DISTRIBUTION AND MASS LOADING OF INSECTICIDES IN THE SAN JOAQUIN RIVER, CALIFORNIA

Winter 1991-92 and 1992-93

by

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PURPOSE

Scientists from the Central Valley Regional Water Quality Control Board tested water quality in the San Joaquin River (SJR) watershed using toxicity tests. They found that water samples from certain areas of the watershed caused a species of water flea (*Ceriodaphnia dubia*) to die. *Ceriodaphnia dubia* is used in these toxicity tests because it is sensitive to insecticides and represents aquatic arthropods (one of the components of the U.S. Environmental Protection Agency three-species toxicity test). Based on these results, the Central Valley Regional Water Quality Control Board suggested pesticides as the possible cause. The Department of Pesticide Regulation (DPR), which is responsible for preventing pesticide contamination of surface water and ground water, conducted a study in the SJR watershed. This report summarizes data collected during the winter dormant spray seasons of 1991-92 and 1992-93. Subsequent reports will summarize results from other periods of high insecticide use.

STUDY METHODS

DPR scientists sampled one site to establish patterns of water quality characteristics and insecticide concentrations at different times during 1991-93. They also sampled many other sites throughout the watershed during several storms to determine mass loading of insecticides in the watershed.

RESULTS

Water quality was consistently poor in the Turlock Irrigation District Drain #5. It had the lowest dissolved oxygen, highest total ammonia, and highest total organic carbon concentrations. Pesticide concentrations were measured using multichemical analytical methods (called screens) which are capable of detecting many pesticides. Screens were used to test for two classes of chemicals--organophosphates and carbamates. There were 108 samples collected in two winters. Analyses showed:

10 percent contained the organophosphate chlorpyrifos,
72 percent contained the organophosphate diazinon, and
19 percent contained the organophosphate methidathion.

Twelve percent contained the carbamate carbaryl. All four insecticides are used on stone fruit or nut crops during the winter. Peak insecticide concentrations occurred when it rained and discharge was greatest. The Newman Wasteway, Orestimba Creek, and Merced and Tuolumne Rivers contributed major amounts of insecticides to the insecticide loads measured in the SJR.

CONCLUSIONS

The Turlock Irrigation District Drain #5 site's water quality measurements were poor relative to other sites in the watershed probably because this drain carries municipal waste water from a sewage treatment plant located upstream.

Chlorpyrifos exceeded the U.S. Environmental Protection Agency's acute water quality criterion to protect freshwater aquatic life at one

site--the Newman Wasteway. Diazinon exceeded the California Department of Fish and Game's suggested criterion of acute toxicity for the protection of freshwater life in about 56 percent of the samples collected in the SJR at Laird Park. In addition, diazinon exceeded this criterion at 12 of 23 sites sampled throughout the watershed. Corresponding criteria for methidathion and carbaryl have not been developed.

Through its Dormant Spray Water Quality Program, DPR seeks to prevent aquatic toxicity from organophosphate pesticide residues (diazinon, chlorpyrifos [Lorsban], and methidathion [Supracide]) in the Sacramento and San Joaquin Rivers. The initial effort focuses on promoting voluntary efforts to prevent aquatic toxicity, for example. Concurrently, monitoring data by DPR will verify compliance with water quality standards. DPR hopes that preventive actions taken by growers will prevent aquatic toxicity and forego the need to impose restrictions. DPR will evaluate the success of the voluntary efforts toward achieving water quality compliance using standard toxicity tests. DPR may impose regulatory measures, depending on the assessment of the monitoring results. As long as progress continues toward compliance with the water quality standard, regulations will be unnecessary.

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ABSTRACT

From 1988-1991, scientists from the Central Valley Regional Water Quality Control Board (CVRWQCB) tested water quality in the San Joaquin River (SJR) watershed using toxicity tests. Results indicated water samples from certain regions of the watershed caused mortality to the cladoceran, *Ceriodaphnia dubia*, and the authors implicated insecticides as the potential cause. Prior to the CVRWQCB tests, little work had been conducted to characterize insecticide concentrations and distributions in this watershed. Due to the lack of information concerning insecticide residues in the watershed, a survey was conducted from 1991-93, focusing on three seasons of high insecticide use: (1) winter dormant spray, (2) spring, and (3) summer seasons. This report summarizes the winter dormant spray season. Additional reports will cover the other two periods. The survey consisted of two components: (1) sampling at one site to establish temporal patterns of water quality parameters and insecticide concentrations, and (2) spatially distributed sampling (Lagrangian surveys) during four storm events to determine mass loading of insecticides in the watershed. Consistently poor water quality was measured in Turlock Irrigation District drain #5, with typically the lowest dissolved oxygen, highest total ammonia, and highest total organic carbon concentrations. Water samples were analyzed for organophosphates, carbamates, and endosulfan. Of 108 samples collected during the two winter seasons, 10, 72, and 19% contained the organophosphates chlorpyrifos, diazinon, and methidathion, respectively. Twelve percent contained the carbamate carbaryl. All four insecticides are used on stone fruits or nut crops during the winter season. Chlorpyrifos concentrations exceeded the U.S. EPA acute water quality criterion established to protect freshwater aquatic life at one site, the Newman Wasteway. Diazinon concentrations exceeded the California Department of Fish and Game's suggested acute criterion in 19 of 34 samples collected in the SJR at Laird Park. In addition, diazinon exceeded this criterion at 12 of 23 sites sampled during the four Lagrangian surveys. Peak insecticide concentrations coincided with rain events and peak discharge. Peak insecticide concentrations found in 1992-93 (a wet winter) were higher than those found in 1991-92 (a dry winter) presumably because in wet years there is greater runoff potential from saturated soils. Lagrangian surveys were useful for identifying tributaries carrying insecticides to the SJR. The Newman Wasteway, Orestimba Creek, and Merced and Tuolumne Rivers were major contributors to insecticide loads measured in the SJR. Results indicate Lagrangian sampling may not be ideal to determine peak loads in all tributaries where a watershed consists of a mixture of large rivers and small creeks. However, they are still useful for identifying major sources of contaminants in a watershed.

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DISCLAIMER

The mention of commercial products, their source, or use in connection with material reported herein is not to be construed as an actual or implied endorsement of such product.

TABLE OF CONTENTS

TABLE OF CONTENTS - Continued

LIST OF TABLES

LIST OF FIGURES

LIST OF FIGURES - Continued

INTRODUCTION

In 1988, scientists from the Central Valley Regional Water Quality Control Board (CVRWQCB) began testing water quality in the San Joaquin River (SJR) watershed using toxicity tests. The purpose of these tests was to characterize water quality in the SJR, its tributaries and drains, and to identify sources of toxicity seen in toxicity tests (Connor, 1988). Results indicated waters from certain regions of the watershed caused mortality to the cladoceran, *Ceriodaphnia dubia* (Foe and Connor, 1991). The specific cause of mortality was not determined but was believed to be caused by pesticide toxicity.

The SJR flows through the northern portion of the San Joaquin Valley, an area of intensive agriculture. In counties with perennial SJR flow (Merced, San Joaquin and Stanislaus Counties), major crop acreages include alfalfa, almonds, beans, corn (silage), grapes, tomatoes, walnuts, and wheat. Over 300 pesticides were used in these three counties, with an annual reported usage of over 19 million lbs in 1992 (DPR 1993).

In spite of the high use of pesticides in this region, little work had been conducted to characterize their distribution in surface water prior to this study. The temporal distribution of pesticides has been monitored monthly by the U.S. Geological Survey (USGS) at one site on the SJR since 1988 (Anderson et al., 1990; MacCoy et al., 1995). This site is part of the USGS National Stream Quality Accounting Network. Pesticide concentrations were also measured once in 1985 at 32 additional sites in the basin (Shelton and Miller, 1988). Pesticides detected in water in these surveys include carbofuran, carbaryl, chlorpyrifos, DDT, diazinon, dieldrin, ethion, lindane, and ethyl and methyl parathion. More intensive spatial and temporal sampling, and pesticide mass-loading in the SJR watershed, had not been conducted at the time this study began.

Due to the reported toxicity of SJR water to *C. dubia* and the need for more information concerning spatial and temporal patterns of pesticide residues in the river, a two-year study was conducted from 1991-93. Analytical screens used for this study focused on insecticides since *C. dubia* is an aquatic invertebrate. Sampling was conducted in three seasons of high insecticide use: (i) the winter dormant spray season (December - February), (ii) the spring season (March - April), and (iii) the summer season (July - September) when a large variety of crops are grown. The objective of these studies is to document the spatial and temporal distribution of insecticides in the watershed during peak use seasons. This report contains data collected during two winter seasons: 1991-92, a drought year for California, and 1992-93, a year with above average rainfall. Subsequent reports will cover the remaining two seasons. Study results will be used to identify regions and seasons of high contamination, and drainage basins contributing highest insecticide loads to the SJR.

Note: Units used in this report are a mixture of metric and non-metric units designed to provide the reader with information in a familiar format.

MATERIALS AND METHODS

Study Area Hydrology

The San Joaquin Valley, approximately 12,000 mi^2, can be divided into two drainage basins, the San Joaquin and Tulare Basins (Fig. 1). The Tulare Basin is a closed basin: water drainage begins and ends within the basin boundaries. In addition, surface water streams are all ephemeral (Domagalski, 1995). In contrast, the San Joaquin Basin drains into the Sacramento-San Joaquin Bay Estuary, a valuable fishing and wildlife resource. The basin contains surface water streams and rivers, both ephemeral and perennial in nature. The SJR itself has perennial flow from Stevinson (site 1 in Table 1 and Fig. 1), northward about 40 river miles to Vernalis (site 17), passing through Merced and Stanislaus Counties. Downstream of Vernalis, in San Joaquin County, tidal influence from the estuary begins. Sampling in this study was restricted to areas of perennial flow in the San Joaquin Basin due to its potential year-round contribution of pesticides to the estuary.

The SJR has three major tributaries on the east side of the valley: the Merced, Tuolumne, and Stanislaus Rivers, which originate in the Sierra Nevada Mountains (Fig. 1). In addition, there are a number of small irrigation district drains which carry excess irrigation water as well as agricultural runoff water from the valley floor to the San Joaquin River and these tributaries. Soils on the east side of the valley, which originate from the Sierra Nevada batholith, are generally coarse textured and well drained (Domagalski, 1995). On the west side of the valley, surface water streams are ephemeral and originate in the Coastal Range. These tributaries frequently carry rain and irrigation runoff from agricultural fields. Soils on the west side, which originate from the marine shales of the Coastal Range, are generally fine textured and highly erodible (Domagalski, 1995).

Sampling Plan

During the winter seasons of 1991-92 and 1992-93, sampling was conducted about twice a week in the San Joaquin River at Laird Park (site 12 in Table 1 and Fig. 1). In 1991-92, sampling was conducted from December 23, 1991, through February 27, 1992. In 1992-93, sampling was conducted from December 29, 1992, through February 25, 1993. This site served as an indicator of the temporal variation in water quality parameters and insecticide concentrations occurring in the study area.

In addition to monitoring the temporal insecticide pattern, the mass loading of insecticides into the SJR was examined using a Lagrangian survey (Hanor, 1988;

Meade and Stevens, 1990). This survey consists of sampling a single parcel of water as it moves down the SJR, capturing tributary inputs as they are timed to meet the main stem of the river. Sites sampled along the main stem of the SJR are timed (using velocity and distance to the next sampling point) so that the same parcel of water is sampled as it moves downstream. Therefore, if two sampling sites are measured along the main stem of the SJR and there are no tributary inputs between them, the discharge should be equal at those two sites, given no major inputs from or losses to groundwater. In addition, insecticide concentrations (and mass) would be equal, given the same assumptions.

In this study, to maximize information about tributary contribution to mass loads of insecticides in the SJR, sampling sites on the main stem were located downstream from major tributaries. Water sampled in a tributary was timed such that the parcel in the tributary arrived in the SJR when the SJR site was to be sampled. For example, the SJR site at Stevinson (site 1) is located above the confluence of Salt Slough (site 2), and is the first sampling site in the study area. When water was sampled at Stevinson, the time required for that parcel of water to reach the next SJR site at Fremont Ford (site 18) was recorded. To determine when to sample Salt Slough, we first used SJR velocity and distance from Stevinson to the confluence with Salt Slough to determine when water sampled at Stevinson would arrive at that location. Then we used the velocity and distance from the Salt Slough site to the confluence with the SJR to estimate what time to collect water from Salt Slough. Velocity data were either available from existing gaging stations or measured. If timed well, the discharge measured at Fremont Ford should equal (within about 10%) the sum of the discharges from Stevinson and Salt Slough. This sampling strategy enables identification of sources of particular constituents to the river, either from a tributary or direct discharge to the main stem. It also facilitates assessment of the magnitude of these sources, using mass balance calculations. Mass loads at each sampling location were determined by multiplying discharge by concentration to obtain lbs/hour.

The Lagrangian surveys were conducted during periods of peak insecticide discharge to the SJR as indicated by results from the temporal survey conducted at Laird Park (site 12). Temporal data indicated rain runoff periods carried the highest concentrations of dormant spray insecticides (see below). Therefore, Lagrangian surveys were conducted the weeks of January 27, 1992, February 17, 1992, January 14, 1993, and February 8, 1993, the first and second storm events of each winter season. Eighteen sites were sampled in 1992 and up to 23 in 1993 (Table 1, Fig. 1).

Water samples were collected with a USGS D77 or DH77 water sampler using the equal-width increment, depth-integration method (Guy and Norman 1970), taking 10 to 30 vertical sections across the stream width. Grab samples were also collected when stream width was too narrow and depth too shallow to use either the D77 or DH77 sampler. All water collected at a site was composited in a stainless steel container then split with a ten-port teflon splitter (USGS designed) into 1-liter glass jars. Split samples were analyzed for total suspended sediment (TSS), total organic carbon

(TOC), organophosphate insecticides (OPs), carbamate insecticides (CBs), and endosulfan (Table 2).

Water Quality Measurements

Water quality parameters measured *in situ* include water temperature, pH, dissolved oxygen (DO), electrical conductivity (EC), and ammonia. Stream discharge was also measured at sites without gaging stations. Water pH was measured with a Cole Parmer ATC pH wand (model 05830-00). Dissolved oxygen was measured with a YSI (Yellow Springs Instruments) dissolved oxygen meter (model 57). Electrical conductivity was measured with a YSI salinity-conductivity-temperature (SCT) meter (model 33). Ammonia was estimated in the field using an ammonia-nitrogen test kit made by CHEMets (model AN-10). Discharge at each site was calculated by measuring stream velocities (using the six-tenths-depth and two-point methods) then summing these velocities across the stream width (Buchanan and Somers, 1969). Velocities were measured using a Price AA current meter (Buchanan and Somers, 1969).

Total suspended sediment and TOC were also measured. To measure TSS, 100 to 200 mL of sample were passed through a pre-cleaned 0.45 µm filter in accordance with USGS procedures (Fishman and Friedman, 1989). The method detection limit is 0.3 mg per sample. To measure TOC, a Dohrmann DC-85A TOC analyzer was used in accordance with instrument instructions (Dohrmann, Santa Clara, CA). The method detection limit for this procedure is 4 mg/L.

Wet/Dry Deposition Sampling

In addition to water sampling, wet and dry deposition samples were collected during the 1992-93 season and analyzed for organophosphates (see below). Wet and dry deposition were measured using an Aerochem Metrics Inc. automatic-sensing wet/dry precipitation collector (model 301, Aerochem Metrics, Inc., Bushnell, FL). Samples were collected in three locations: Caswell State Park along the Stanislaus River (water-sampling site 16), George Hatfield State Recreation Area along the Merced River (water-sampling site 6), and McConnell State Recreation Area along the Merced River (site 24, Table 1). Samplers had to be located in secure areas with a power supply; therefore, they could not be evenly spaced throughout the valley. Data were used to qualitatively assess atmospheric contribution of the insecticides to the watershed.

Pesticide Analysis

Water samples were screened for organophosphate (OP) and carbamate (CB) insecticides (Table 2), and endosulfan (I, II, and sulfate forms). In the OP screen, 14 parent insecticides (excluding diazinon) and nine breakdown products were analyzed. In the CB screen, six parent insecticides and three breakdown products were analyzed. To preserve chemical constituents prior to analysis, the OP and CB samples were acidified to a pH of 3.0. In most cases, these insecticides were adequately preserved at pH 3.0 for at least 2 weeks in storage at 4°C (Appendix I). However, diazinon broke down rapidly at this pH and therefore was analyzed in the endosulfan sample, which was not pH adjusted.

Organophosphate Screen

Water and wet deposition samples (about 1L) were extracted with 100 mL methylene chloride by shaking for 2 min. The methylene chloride layer was drained through 20 g sodium sulfate and transferred to a 500 mL round bottom flask. The sample was extracted two more times, dried, and added to the round bottom flask. The solvent was evaporated to dryness using a rotary evaporator at 35°C and transferred with one 5-mL rinse, and two 2-mL rinses with acetone, to a calibrated tube. The extract was reduced to 0.5 mL under N_2 without heat, and brought to a final volume of 1 mL with acetone. Analysis was performed by gas chromatography (GC) using a Varian Model 6000 (Varian, Palo Alto, CA) or a Hewlett Packard GC model HP-5890 (Wilminton, DE), equipped with a flame photometric detector and a Hewlett Packard, HP-1 methyl silicone-gum column (10 m by 0.53 mm by 2.65 µm). Initial oven temperature was 150°C, held for one min, and increased to 200°C by 10°C/min, and held for two min. This temperature was then increased to a final temperature of 250°C by 20°C/min and held for five min. Injector and detector temperatures were 220°C and 250°C, respectively. Method validation recoveries are listed in Appendix II.

Carbamate Screen

Water samples (about 100 g) were extracted using three 100-mL aliquots of methylene chloride, shaking vigorously for one min. Solvent layers from all three extractions were poured into a 500 mL round bottom flask and concentrated to 3-5 mL on a rotary evaporator at 30-35°C. About one g of sodium sulfate was used to remove any water from the concentrate and then filtered through a 0.45 µm filter into a calibrated tube. The flask was rinsed with two 2-mL aliquots of methylene chloride and filtered through the same filter into the same tube. The extract was reduced to dryness under N_2 at 35°C, brought to a final volume of 0.2 mL with methanol, and mixed for about 15 sec using a vortex. Immediately prior to high performance liquid chromatography analysis, 0.9 mL of water were added and the sample mixed for about 15 sec using a vortex, and transferred to an autosampler vial. Analysis was performed using a Hewlett Packard 1090 Liquid Chromatograph equipped with a C18 column (4.6 mm by 25 cm by 5µm), a Pickering Labs post-column derivatization system (Pickering Labs, Mountain View, CA) and a Hitachi F1000 fluorescence spectrometer set at 340 and 450 nm excitation and emission wavelengths,

respectively. A water-acetonitrile gradient was used to separate the analytes. Method validation recoveries are listed in Appendix II.

Diazinon and Endosulfan Screens

Water samples (about 1 L) were extracted twice with 100 mL and once with 80 mL aliquots of methylene chloride, shaking for 1.5 min, venting often. Solvent layers were drained through 30 g sodium sulfate into a 500 mL flat-bottomed boiling flask. The sodium sulfate was rinsed with three 10-mL aliquots of methylene chloride and added to the flask. The extract was evaporated just to dryness on a rotary evaporator at 40°C and transferred to a calibrated tube using 8 to10 mL of acetone and brought to a final volume of 2 mL under N_2 at 40°C.

For diazinon, analysis was performed by GC using a HP 5890 equipped with a flame photometric detector and a HP-1, methyl silicone gum column (10 m by 0.53 mm by 2.65 µm). Initial oven temperature was 150°C, held for two min, and increased to a final temperature of 200°C (held for one min) by 10°C/min. Injector and detector temperatures were 220°C and 250°C, respectively. Method validation recoveries are listed in Appendix II.

For endosulfan, a florisil clean-up procedure was used, when necessary, prior to analysis. The extract solvent was exchanged from acetone to hexane under N_2 at 35°C. Extract was poured into a column filled with 10 cm heat-activated florisil, topped with 12 mm sodium sulfate and pre-wet with 50 mL hexane. The extract was loaded quantitatively to the column and eluted with 200 mL of a 50% diethyl ether:hexane (containing 10-25 g anhydrous sodium sulfate) and collected in a 500 mL flat-bottomed boiling flask. The eluant was reduced to 2 mL on a rotary evaporator at 40°C, transferred to a calibrated tube using 8 to 10 mL hexane, and brought to final volume of 2 mL under N_2 at 40°C. Analysis was performed by GC (Varian Model 6000) equipped with an electron capture detector and a HP-1 capillary column, 25 m by 0.2 mm by 0.33 µm. Initial oven temperature was 150°C, held for two min, and increased to 250°C by 25°C/min, and held for six min. Injector and detector temperatures were 230°C and 300°C, respectively. Method validation recoveries are listed in Appendix II.

Dry Deposition

Dry deposition of organophosphates was measured from two stainless steel plates placed inside the wet-dry deposition sampler (described above). The plates were placed in a glass jar and extracted using 500 mL of acetone and sonicated for 5 min. The extract was poured into a 1-L flat bottom flask and rotoevaporated in a water bath at 40°C and 20 inches of vacuum. The extract was then quantitatively transferred to a test tube and brought to a final volume of 1 mL under N_2 at 40°C. The analysis was performed by GC, as described above for organophosphates in water.

Quality Control

As part of our quality control (QC) program, data generated during method validation (see Appendix II) were used to assess all subsequent study results. Specifically, the data were used to establish warning and control limits similar to that described by Miller and Miller (1988). A warning limit is the mean ± 2s, where the mean is the average % recovery found in method validation and s the standard deviation (Appendix II). A control limit is the mean ± 3s. Continuing QC samples consisted of water samples spiked with an analyte at a given concentration, extracted and analyzed with each extraction set. An extraction set consists of one to 14 field samples, and depends on how many samples are received in the laboratory for processing at any one time. During the course of the study, continuing QC samples are compared back to the warning and control limits. If a continuing QC sample exceeds the warning limit, the chemist is notified. If the continuing QC sample exceeds the control limit, corrective measures are taken in the lab to bring conditions back under control. Only field samples potentially low in concentration, as indicated by QC results that are below the lower control limit, are noted in the report. In addition, blind spikes were analyzed. A blind spike is a surface water sample that is spiked by one chemist and submitted to another for analysis. The analyte and concentration of blind spikes is therefore not known by the chemist performing the analysis.

As an additional quality assurance measure, field-rinse samples were prepared periodically after sample collection. In the field, all sampling equipment was cleaned with four distilled-water rinses after each sample was collected. Field-rinse samples were prepared by pouring distilled water into all sampling equipment after a typical cleaning procedure. These samples were then collected in one-liter amber glass jars, as was done for all water samples. Field-rinse samples were transported and stored with other water samples, and analyzed for all insecticides as well as TSS and TOC. Field-rinse samples served as a check on potential sample contamination during collection, transport, and storage.

RESULTS AND DISCUSSION

Pesticide and Land Use

During winter months, many growers apply dormant spray insecticides to stone fruit and nut crops to control over-wintering peach twig borer (*Anarsia lineatella*) and San Jose scale (*Quadraspidiotus perniciousus*). Chlorpyrifos, diazinon, and methidathion, along with weed oil, are typically used to control these pests. Ethyl parathion was also commonly used prior to the U.S. EPA ban on its use as a dormant spray insecticide at the end of 1991.

The dormant spray season usually occurs from December to February, during which time applications vary with weather patterns. During the two winters under study, the highest applications occurred in January in both Merced and Stanislaus Counties (Table 3). In the 1991-92 winter season, about 43,000 lbs, 76,000 lbs, and 24,000 lbs of chlorpyrifos, diazinon, and methidathion were applied, respectively, in these two counties (DPR 1991, DPR 1992). In 1992-93, about 31,000 lbs, 77,000 lbs, and 16,000 lbs of chlorpyrifos, diazinon, and methidathion, were applied, respectively, in these two counties (DPR 1992, DPR 1993). In both 1991-92 and 1992-93, diazinon use was highest, followed by chlorpyrifos, then methidathion in both counties.

Dormant spray on almonds is the major use for these insecticides during winter months (Table 4). Most almond orchards are located east of the San Joaquin River where dormant spray use is also highest (DPR 1991-3). Use of dormant sprays is also predominant during winter months on the west side. Although lower in quantity (see below), the west side may be a significant source of dormant spray insecticides because of the greater runoff potential from these fine-textured soils.

Quality Control

All continuing QC sample results are listed in Appendix III. Blind spike results are listed in Appendix IV. For the OP screen, 361 QC spikes were made during the two winters. Of these, 340 were continuing QC spikes, and 21 were blind spikes. Of the 361 OP spikes, 17 were above the upper control limits (Table 5 and Appendix IV), indicating analytical results may over-estimate the actual concentration about 4.7% of the time. Of 361 OP spikes, four fell below the lower control limits (Table 5 and Appendix IV), indicating results may under estimate actual concentrations about 1% of the time. Field samples analyzed with continuing QC values below the lower control limit are noted in the data tables. Potential over estimation of a concentration was not reported for two reasons: 1. Most field samples analyzed with continuing QC samples above the control limit were none detects, and 2. errors on the high side are more conservative where environmental protection is concerned.

Of 287 CB spikes (seven of which are blind spikes), eight (2.8%) were above and five (1.7%) were below the control limits (Table 5 and Appendix IV). Of 174 endosulfan screen spikes (nine of which were blind spikes), nine (5.2%) were above and one (0.6%) was below the control limits (Table 5 and Appendix IV). Again, field samples analyzed with continuing QC values below the lower control limit are noted in the data tables.

There was a relatively small number of QC samples falling outside the control limits for each of the three screens. Most were above the control limits. A much smaller percentage fell below the control limits. Due to the small number of samples that may be affected, this is not expected to influence study conclusions. Also, paired comparisons with the USGS laboratory during the two year SJR study showed that our

results were equal to or higher than the USGS in 24 of 30 paired comparisons (see data reported in Foe, 1995, pages 48-50). Therefore, compared with another laboratory, our results tend to err on the high side as well. Laboratory biases such as this are not uncommon (Horwitz, 1978; Burke, 1978). In the future, to improve laboratory performance, QC measures should involve reanalysis of a backup sample once continuing QC spikes are brought back within control limits.

Finally, TOC, TSS, and insecticides were not detected in the 13 field-rinse samples collected during the two winter seasons (Appendix V).

Water Quality Objectives and Criteria

Water quality measurements and insecticide concentrations will be compared with acute objectives and criteria designed to protect freshwater aquatic life. Objectives established by the CVRWQCB (1994) will be used as the primary comparison. If the CVRWQCB has not established an objective for this watershed, the most recent U.S. EPA freshwater criterion (1986 and 1987) will be used. If the U.S. EPA has not established a criterion, the water quality criterion suggested by the California Department of Fish and Game (CDFG) will be used. The criteria established by these agencies were selected for comparison because they follow established U.S. EPA methodology.

In addition, comparisons will be made only with acute objectives and criteria since samples collected in this study were short-term in nature (i.e. samples took anywhere from a few minutes to one hour to collect). Comparison with chronic values is not appropriate under these circumstances since chronic criteria are applied to longer time periods. For example, U.S. EPA chronic criteria require averaging over a four-day period. Meaurements in this study reflect a maximum of two hours, during any given 96-hour (4-day) period. Therefore comparisons with chronic criteria were not made.

Finally, acute criteria are site specific, *i.e.*, criteria are not to exceed a calculated value more than once every three years at a given location. Therefore, comparisons with acute criteria will be made on a site by site basis using the data available.

Water Quality Measurements

Temporal Variation at Laird Park

Water quality measurements were made at Laird Park (site 12) about twice weekly, from the end of December through the end of February, in both years (Fig. 2, Appendix VI). Water temperatures at the time of sampling ranged from 7.5 to 16°C and pH ranged from 6.1 to 7.7. One pH value, measured on Jan. 11, 1993, was below the minimum water quality objective established by the CVRWQCB

(CVRWQCB, 1994; Table 6). Potential reasons for low pH in natural streams include changes in carbonate equilibrium and pollution loading (Goldman and Horne, 1983; Connell and Miller, 1984). However, the reason for this particular low value is not clear from the data collected.

In addition to temperature and pH: DO, EC, and total ammonia were measured (Fig. 2). Dissolved oxygen ranged from 6.9 to 10 mg/L, with one measurement below the CVRWQCB objective of 7.0 for this habitat (Table 6; see CVRWQCB, 1994, for habitat designations). Electrical conductivity ranged from 270 to 1630 µS/cm. These EC values are similar to those reported before in the SJR (Shelton and Miller, 1988; Anderson et al., 1990). Water quality objectives and criteria have not yet been established for this parameter. Total ammonia ranged from 0.2 to 3 mg/L. Criteria for ammonia concentrations are dependent on water temperature and pH. Ammonia concentrations at Laird Park (site 12) did not exceed the criteria recommended by the U.S. EPA (Table 6).

Maximum discharge in 1992-93, was higher than in the winter of 1991-92, as the six year drought came to an end (Figures 3 and 4). Discharge measured at Laird Park ranged from 434 to 2455 cfs in 1991-92 and from 416 to 4950 cfs in 1992-93. Peak discharges coincide with rain events, when rainfall exceeds the soil infiltration rate and surface storage capacity (Hillel, 1982).

Total suspended sediment ranged from 22 to 1100 mg/L with the highest TSS concentrations occurring just prior to peak discharges (Fig. 2). Numerical objectives for this parameter have not been established. However, high amounts of suspended sediment may cause changes in the aquatic system including increased drift of benthic organisms (White and Gammon, 1976; Rosenberg and Wiens, 1978), high mortalities of benthic plants and invertebrates, decreased light penetration, changes in foraging and mating behavior of certain organisms, and clog gills of some animals impairing respiration (Connell & Miller 1984). However, from the data collected in this study, it is not known if any of these changes occurred in the watershed.

Total organic carbon ranged from <4 to 24 mg/L and fell within the range of concentrations measured previously in the SJR (Shelton and Miller, 1988; Anderson et al., 1990).

Comparison of water quality distributions between winters indicates overlap of the 25th and 75th percentiles for all parameters except discharge (Fig. 5), indicative of two very different water years. In addition, a t-test (Sokal and Rohlf, 1973) indicated the mean discharges from the two years were significantly different, as were the inversely correlated water quality measures of pH and EC (Appendix VIII).

Lagrangian Surveys

Water temperatures varied with location and ranged from 8.0 to 15°C (Fig. 6, Appendix VII). Warmest temperatures typically occurred at site 9 (TID #5). The pH ranged from 6.3 to 8.4, with values below the 6.5 objective occurring once at sites 5,6,7, and 13 (Fig. 6).

Dissolved oxygen ranged from 2.3 to 14 mg/L (Fig. 6), values indicating deoxygenated and super-saturated conditions, respectively. Ten measurements were below the CVRWQCB objective established for spawning habitat (Table 6). Four of the ten were measured in TID #5, where the DO values ranged from 2.3 to 4.1 mg/L. This site frequently carries waste water from a waste water treatment plant operated by the city of Turlock. Primary waste water treatment plants may discharge high amounts of ammonia and organic carbon (see below), increasing the biological oxygen demand in the receiving waters, thereby reducing the amount of oxygen dissolved in the water (Tchobanoglous and Schroeder, 1985). Also, water in this drain tended to be warmer than at other locations, which also tends to lower DO. Two DO measurements made in the Newman Wasteway (site 5) were also below the objective. Water at this site is frequently stagnant and at the time of low DO measurements there was no discharge. The remaining four DO measurements below the objective occurred once at Stevinson, Los Banos Creek, Hills Ferry, and Patterson (sites 1, 4, 7, and 10, respectively).

Electrical conductivity ranged from 85 µS/cm at the Merced River (site 6) to 5690 µS/cm at Los Banos Creek (site 4; Fig. 6). The Merced, Tuolumne, and Stanislaus Rivers (sites 6, 13, and 16) were all consistently below 700 µS/cm, a proposed agricultural water quality goal mentioned by Marshack (1993). Salt and Mud Sloughs, and Los Banos Creek (sites 2,3, and 4) were consistently above this goal during the four Lagrangian surveys. These sites are located in or near Kesterson National Wildlife Refuge, an area traditionally high in selenium and other salts, contributing to high EC of the waters in this area (CVRWQCB, 1988). In addition, EC at TID #5 (site 9) was consistently above 700 µS/cm. High conductivity is also associated with treated domestic waste (Tchobanoglous and Schroeder, 1985). Overall, the highest EC values were reported during the first Lagrangian survey in January 1992, when discharge in the watershed was lowest (Fig. 6).

Total ammonia ranged from <0.1 to >10 mg/L (Fig. 6), values above and below the detection limits. Turlock Irrigation District drain #5 (site 9) typically had the highest total ammonia concentrations of all sampling sites. In addition to being downstream of a waste water treatment plant, this site is located adjacent to a rendering plant, which in the past was a source of ammonia. There are also a number of dairies that discharge into TID #5, another potential source of ammonia in this drain. It is unknown whether the U.S. EPA criteria for ammonia were exceeded at this site since all concentrations exceeded the upper limit of the test. Ammonia concentrations measured at all other sites were below the U.S. EPA's water quality criteria for the protection of aquatic life.

During the Lagrangian survey, TSS ranged from 5 to 1800 mg/L (Fig. 6). The highest TSS concentrations occurred in Spanish Grant drain, TID# 5, and Ingram/Hospital Creeks (sites 19, 9, and 14, respectiveiy). Spanish Grant Drain and Ingram/Hospital Creeks are located on the west side of the SJR, an area of fine textured soils prone to erosion.

Total organic carbon concentrations ranged from <4 to 210 mg/L (Fig. 6), with highest concentrations found at TID# 5 (site 9). Total organic carbon tends to be high in areas of human and animal waste discharges (Tchobanoglous and Schroeder, 1985). Turlock Irrigation District Drain # 5 carries municipal waste from the water treatment plant operated by the city of Turlock. There are also a number of dairies along this drain, which periodically discharge animal waste upstream of this sampling site.

A principal component analysis (PCA) was conducted on the water quality measurements made during the Lagrangian surveys. This type of analysis is useful for reducing a multi-dimensional data set (i.e. a multi-variable data set) to two to four important variables. Results are displayed on a two-dimensional graph and clustering of observations is examined. In this PCA, TID #5 (site 9) ordinated in a different position from all other sites using the first two principal components as x and y axes in Figure 7. Principal component one (the x-axis), had a high negative eigenvector for DO and high positive eigenvectors for ammonia and TOC (Table 7). The association of factors on this loading is related to the significant inverse correlation between DO and ammonia, and DO and TOC. Translating this information to Figure 7, the x-axis is indicative of DO, where higher x-axis values equate to lower DO values. Similarly, ammonia and TOC had positive eigenvector loadings, the higher x-axis values equate to higher ammonia and TOC concentrations. Principal component two had a high positive eigenvector loading for EC and pH, water quaity measures that were also significantly correlated. The y-axis is interpreted similarly, sites ordinating higher on the y-axis, are those with high EC and a tendency for high pH. The unique position of TID #5 observations in this figure indicates that the combination of water quality measurements made there, particularly DO, EC, and ammonia, are somewhat different from elsewhere in the study area. Likewise, the grouping of Salt and Mud Sloughs and one Los Banos Creek observation (sites 2, 3, and 4, respectively), ordinate in a different position than most other sites, indicative of high EC values measured there. The first two axes account for 65% of the variation in the data set.

Temporal Variation in Insecticide Concentrations

Organophosphates

Chlorpyrifos was detected in two of 30 samples collected during the temporal survey at Laird Park (site 12, Table 8). Neither detection, exceeded the acute criterion of 0.083 µg/L established for the protection of freshwater aquatic life (U.S. EPA, 1987).

Diazinon was detected in 25 of 34 samples collected at Laird Park (site 12, Table 8). Diazinon detections ranged from 0.06 to 1.29 µg/L, with peak concentrations

coinciding with rain events (Figures 3 and 4). Numeric objectives and criteria for the protection of aquatic life have not been established by the CVRWQCB or U.S. EPA for diazinon. The CDFG has suggested that " freshwater aquatic organisms should not be affected unacceptably if the one-hour average concentration does not exceed 0.08 µg/L ..." (Menconi and Cox 1994). Of 34 samples, 19 exceeded this suggested criterion during the two winter seasons.

Methidathion was detected in six of 30 samples collected during the temporal survey (Table 8). All except one detection occurred during rain events. Numeric criteria for methidathion have not yet been established.

Carbamates

Only one CB was detected at Laird Park (site 12) during the temporal survey. Carbaryl was detected once at a concentration of 0.05 µg/L (Table 8). Numeric criteria for the protection of freshwater aquatic life have not yet been established for carbaryl (CVRWQCB, 1994; U.S. EPA, 1986; U.S. EPA, 1987).

Rainfall and Temporal Variation in Diazinon Residues

Peak diazinon concentrations at Laird Park (site 12) coincided with rain events, once soils became saturated from winter storms. In 1991-92, the sixth year of drought in California, the monthly total rainfall in December 1991, was 1.17", reported in Modesto. Cumulative rainfall since July 1991, was 2.53". The first major rainfalls of the winter season (>1"), occurred in early January, prior to most of the season's diazinon applications (Fig. 3). Diazinon concentrations did not increase following this rain event. In addition, river discharge did not change indicating rain runoff in the valley was minimal. With the second storm in February 1992, and with most of the season's diazinon applied, a peak concentration of 0.35 µg/L was reported just prior to peak discharge at Laird Park. Rain runoff from orchards was observed during this event and likely contributed to reported diazinon concentrations.

In 1992-93, a relatively wet year in California, the first rain in January also occurred prior to most of the season's diazinon applications yet a peak concentration of 1.29 µg/L of diazinon was reported just prior to peak discharge on 14 January 1993 (Fig. 4). The peak concentration reported in the 1992-93 winter season was higher than that reported in 1991-92. Similar patterns were seen for chlorpyrifos, methidathion, and carbaryl. The relatively wet year might have contributed to this difference. Cumulative rainfall at Modesto since July was 3.98" with 2.86" falling in December 1992, over one inch more than during the same periods in 1991. It is likely that repeated rain in December 1992 saturated the soil. Once saturated, diazinon residues on the orchard floor moved off-site with rain runoff in later storms. Additional data from various water years would be required to determine if this pattern is reproducible and statistically significant.

Differences in diazinon concentrations seen at Laird Park during the two winters was not likely due to differences in amount of diazinon applied prior to each storm. Five weeks prior to the first storm event in January 1992 and January 1993, 7,360 lbs and 8,320 lbs of diazinon were applied, respectively, in Merced and Stanislaus Counties combined. Five weeks is equivalent to about 2 to 2.5 soil dissipation half-lives of diazinon, measured in almond orchard soils in the Central Valley during the winter dormant spray period (Ross, 1996; Glotfelty, et al. 1990.) However, the first storm in 1991-92 did not generate runoff, so a between year comparison can not be made. Peak concentrations during the second storms were 0.35 and 1.22 ug/L in February 1992 and February 1993, respectively. Total diazinon use between the first and second storms was 64,720 and 63,440 lbs in 1992 and 1993, respectively. Therefore, differences in peak concentrations between the two winters does not appear to be related to use.

In addition to runoff from treated fields, another potential source of insecticides during storm events is rain water. Concentrations in rainfall reached a maximum of 1.9 µg/L of diazinon on February 8, 1993 (Table 9). In contrast, the peak diazinon concentration in rain runoff from almond orchards treated in January 1994, was 21 times higher than rainfall concentrations (Ross, 1996). In addition, less than 5% of the diazinon measured on the soil, was captured in that runoff water. This indicates a large amount of diazinon is bound on site by vegetation and soil. Applying this pattern to diazinon in rain water, we would assume that much less than 100% of the diazinon in rain water would leave an agricultural field given the same conditions. However, in order to quantify the contribution of treated fields vs. the area over which rainfall and subsequent runoff occur, a watershed model is required. Future work with a watershed model will be conducted to better evaluate these sources of diazinon in the watershed.

Diazinon mass at Laird Park, calculated as the product of concentration and discharge, peaked at 0.077 lbs/h in February 1992: and 1.2 and 0.66 lbs/h in January and February 1993, respectively (Fig. 8). Mass loads in 1993 were higher than in 1992 due to higher discharge and higher concentrations. Comparison with data collected by Kuivila and Foe (1995) in the SJR at Vernalis during January and February 1993 indicates 67 to 100% of the diazinon mass exported to the Delta during storm events, originates upstream of Laird Park.

Once diazinon was detected, concentrations did not drop below detection limits, even between rain events (Figures 3 and 4). Potential sources during dry periods include: (1) irrigation runoff, (2) drift, post-application volatilization and dry deposition, and (3) fog deposition. Continued runoff in 1991-92 does not appear to be the source of diazinon after the first storm since discharge at Laird Park did not change more than 100 cfs (Fig. 3). However, since 1991-92 was the sixth year of drought in California, growers were irrigating their orchards during winter months to keep their trees alive and therefore irrigation runoff may have been a factor that year. Glotfelty et al. (1990) showed evidence of drift during application and post-application volatilization of

diazinon from an almond orchard in the San Joaquin Valley. They concluded application-drift losses were small relative to long-term volatilization losses. Diazinon residues have been reported in fog by various scientists (Turner et al., 1989; Glotfelty et al., 1987; Seiber et al., 1993). In addition, Turner et al. (1989) found diazinon residues deposited onto fallout cards during wet and dry periods in Stanislaus County during the winter. Wet and dry deposition were also measured for chlorpyrifos and methidathion. Air, rain and snow samples collected in the Sierra Nevada Mountains contained diazinon and chlorpyrifos, indicating the long-range transport potential of these insecticides (Zabik and Seiber, 1993). Future work with watershed models might help quantify the contribution of wet and dry deposition, and thereby facilitate mitigation efforts to reduce residues in surface water.

Lagrangian Surveys

Organophosphates

Chlorpyrifos was detected in ten of 78 samples collected. Concentrations ranged from 0.06 to 0.22 µg/L (Table 10). All detections, except one, occurred in 1993 and nearly half of these detections were in the Merced River watershed where some of the heaviest use of chlorpyrifos occurs (Fig. 9 and 10). The U.S. EPA acute freshwater criterion was exceeded at the Newman Wasteway (site 5).

Diazinon was detected in 57 of 78 samples collected (Table 10). Diazinon was found at every site in the watershed except Del Puerto Creek (site 11). Diazinon concentrations ranged from 0.05 to 36.8 µg/L. The highest concentration, found in the Newman Wasteway (site 5) on February 9, 1993, was an order of magnitude higher than the next highest concentration, also found in the Wasteway. This site also had the highest chlorpyrifos and methidathion concentrations (see below). The Newman Wasteway is a cement lined channel constructed to carry operational spill water from the Delta Mendota Canal to the SJR and to carry agricultural runoff water from the area, including rain and irrigation runoff water. In winter, the Newman Wasteway carries little water from the Delta Mendota Canal and is frequently stagnant. During rain events, water in this channel is predominantly comprised of agricultural-runoff water. In addition, edge of orchard measures of diazinon in this watershed during the winter of 1994 were between 20 and 30 µg/L, indicating orchard runoff as a likely source of diazinon during rain events (Ross, data not shown).

In addition, diazinon oxon, the oxidation product of diazinon, was detected once at each of three sites: the Newman Wasteway, Stevinson Spillway, and Highline Spillway (sites 5, 22, and 23, respectively). The CDFG acute criterion was exceeded at 12 of 23 sites.

Fonofos was detected once in the Spanish Grant Drain (site 19) at 0.14 µg/L (Table 10). Numeric criteria for the protection of aquatic life have not yet been established by the CVRWQCB or U.S. EPA. This insecticide is typically used on tomatos, peppers,

and beans in March, April, and May in Merced and Stanislaus Counties. The field dissipation half-life of fonofos in soil is about 22 d. Therefore, residues reported here are probably a laboratory error or from unreported use. To check for laboratory error, a split sample was analyzed; this too showed fonofos present. (Mass spectrum confirmation could not be performed on these samples because the concentration was too low.) Given that both blind spikes for fonofos were outside laboratory control limits, it is possible this detection was an error. However, monitoring for fonofos should continue, to assure that it is not a surface water contaminant.

Methidathion was detected in 16 of 78 samples collected during the Lagrangian surveys (Table 10). Concentrations ranged from 0.07 to 12.4 µg/L. Numeric criteria have not yet been established by the CVRWQCB, U.S. EPA, or CDFG for this insecticide.

Phosmet was detected once in the Livingston Spillway (site 21) at a concentration of 3.2 µg/L (Table 10). Numeric criteria have not yet been established by the CVRWQCB, U.S. EPA, or CDFG for this insecticide. Relatively small amounts of phosmet (about 1800 lbs in Merced and Stanislaus Counties in winter 1991-92) are used during the dormant season on almonds and peaches.

Carbamates

Carbaryl was detected in 12 of 78 samples collected (Table 10), 9 of which occurred during the 1992-93 survey. Concentrations ranged from 0.06 to 3.95 µg/L, where the maximum concentration occurred in the Merced River (site 6) during the February 1993 Lagrangian survey. This site, in addition to input from TID #5 (site 9), contaminated the SJR downstream to Vernalis (site 17). In both winters, the Newman Wasteway (sites 5) and TID #5 were sources of carbaryl in this watershed. Carbaryl is used on almonds and peaches during winter months. Use in the 1992-93 season (December - February) totaled 1,750 lbs (DPR, 1992; DPR, 1993) and was concentrated near the Tuolumne and Stanislaus Rivers (Fig. 11). There was some use adjacent to the Merced River, although not high in comparison to other areas. These data could indicate a direct source, e.g., a mixing loading area or fields with drainage directly to the river. In addition, carbaryl use is common in urban areas, which discharge into the Merced River and TID #5. However, from the data available, it is not possible to distinguish urban from agricultural sources. Therefore, it is not clear why carbaryl was detected in the Merced River and not other tributaries where higher agricultural use occurred. Finally, numeric criteria have not been established for carbaryl.

There was one detection of carbofuran and one of aldicarb sulfoxide in TID #5 (site 9) on Feb. 18, 1992. Carbofuran did not exceed the CVRWQCB performance goal of 0.40 µg/L (CVRWQCB). Numeric criteria have not been established for aldicarb sulfoxide.

Endosulfan

Endosulfan was detected in two of 78 samples collected during the Lagrangian surveys (Table 10). Both detections occurred in the 1991-92 season. Neither detection exceeds the acute freshwater criterion for total endosulfan of 0.22 µg/L established by the U.S. EPA for the protection of freshwater aquatic life (U.S. EPA, 1986, Table 6). In addition, in 1991, DPR recommended endosulfan use permits be issued only for properties that do not drain into surface waters of the state. Prior to this recommendation, endosulfan had been found in fish in the SJR watershed (Rasmussen and Blethrow, 1990). One fish sample has been taken from this area since these use restrictions went into effect and it did not contain endosulfan (Rasmussen, 1995). Additional monitoring will help determine the effect of these new use restrictions.

Physical-Chemical Properties and Insecticide Occurrence

In addition to use patterns, physical and chemical properties of the insecticides are important for describing surface water residues. In spite of chlorpyrifos use being nearly twice that of methidathion, methidathion was found more frequently and at higher concentrations. Solubility, soil adsorption, and half life are factors potentially contributing to the patterns seen. In terms of soil and field dissipation half lives, chlorpyrifos > diazinon > methidathion (Table 11). From this information alone, one might expect chlorpyrifos concentrations to be higher than methidathion, given their use patterns. However, the time elapsed between application and storm events may be as short as 24 hours (DPR, 1992; DPR, 1993), so this factor may not be as critical as solubility and soil adsorption. In order of increasing solubility chlorpyrifos < diazinon < methidathion (Table 11). Also, chlorpyrifos has a relatively high K_d, while diazinon and methidathion have lower K_d values. Therefore, chlorpyrifos is expected to be tightly bound to soil particles, either on the field or on eroded soil suspended in the water column or settled onto bottom sediment. In contrast, diazinon and methidathion will most likely be found dissolved in water. Thus, differences in solubility and soil adsorption may explain why methidathion was detected more frequently and at higher concentrations than chlorpyrifos, in spite of its lower use.

Mass Loading of Insecticides

Mass loading calculations are useful for (a) determining major sources of contaminants, (b) estimating instantaneous, daily, annual, or storm event loads, and (c) providing information about the behavior of contaminants during transport in a watershed. Mass load calculations and diagrams were made for chlorpyrifos, diazinon, and methidathion (Fig. 12). Mass loads at any given site in the SJR below a tributary should equal (within +/- 30%, based on split sample variability, Table 10) the sum of the masses calculated for the previous SJR site and the tributaries that occur in between. For example, in the February 1993 Lagrangian survey for diazinon, the

mass in the SJR at Patterson (0.44 lbs/hour) should equal the sum of the masses from tributary sites Orestimba Creek (0.004 lbs/hour) + Spanish Grant Drain (0.0002 lbs/hour) + TID #5 (0.03 lbs/hour), plus the SJR site at Hills Ferry (0.40 lbs/hour). The expected sum (0.4342 lbs/hour), is within 2% of the measured sum and indicates Lagrangian sampling was achieved.

During storms in February of both years, the greatest number of insecticides were detected with the widest distribution (Table 10); therefore, mass loads were calculated for these storm events (Fig. 12). Chlorpyrifos loading into the SJR in February 1992 was solely from the Merced River. In February 1993, the Merced River was again a source of chlorpyrifos, in addition to the Newman Wasteway and TID #5. In the SJR at Hills Ferry, chlorpyrifos was not detected probably because dilution water from upstream lowered the concentration below our detection limits. In this case, as confirmation of true Lagrangian sampling we can perform two procedures: (1) sum the discharges of the inputs below the sampling site and determine if it is within 10% of the measured discharge, and (2) back calculate a theoretical concentration from the sum of the sources to see if it is within +/- 30% of the measured concentration. (Note: 10% is used for discharge comparisons because the method is typically precise to this degree). The sum of the discharges from the SJR at Fremont Ford (426 cfs) + Newman Wasteway (38 cfs) + Los Banos Creek (69 cfs) + Mud Slough (69 cfs) + Merced River (336 cfs) was 938 cfs, within 10% of the discharge measured at Hills Ferry (1040 cfs). If we back-calculate a concentration for Hills Ferry, adding the mass inputs from each source, we get a theoretical concentration of 0.03 µg/L, below our 0.05 µg/L detection limit. This is consistent with true Lagrangian sampling, as well as supports the assumption that residues were diluted below the detection limit at Hills Ferry. Using the same strategy, minor inputs (below our detection limits) probably exist between Hills Ferry and Patterson, in addition to TID #5 (Fig. 12). Additional inputs were not detected downstream of Patterson.

Chlorpyrifos use is high in the Merced River region of the watershed (Figures 9 and 10), and the mass load calculations support this. However, use is also high in the Tuolumne River region, where chlorpyrifos was not detected. There are 14 discharge points to the Tuolumne River between its confluence with the SJR and highway 99 (CVRWQCB, 1989). Seven of these discharge points occur within the first 2.8 mi of the confluence with the SJR. Our sampling location was about 3.5 mi upstream of the SJR and thus upstream of these discharges. However, from mass load calculations, these do not appear to carry measurable insecticide residues (Fig. 12).

Sampling was conducted about 15 h prior to peak discharge on the Tuolumne River. Peak concentrations typically occur either just prior to peak discharge or during peak discharge (Domagalski, 1995, Kuivila and Foe, 1995). Since the study area is large, it is difficult to catch each individual tributary as it reaches it's peak discharge because rainfall distribution is heterogeneous and the response of each sub-basin to rainfall varies. For example, storms typically move from west to east in this region, first dropping rain on the smaller tributaries arising from the coastal range, followed by

rainfall in the valley, then the foothills of the Sierra Nevada mountains. Peak discharge in west-side tributaries will therefore occur sooner than those in the east, not only because the storm arrives there sooner but because the watersheds are smaller. Likewise, if a storm has a slight south-north trajectory, tributaries in the south will peak sooner than tributaries in the north. Therefore, it is possible residues were not detected in the Tuolumne River because measurements were taken too early. Additional monitoring for pesticides and their sources in the Tuolumne River watershed will be conducted by the USGS in subsequent winters (personal communication, Charlie Kratzer).

Diazinon loading in February of 1992 was also lower than in February 1993 (Fig. 12). The largest sources of diazinon were the Tuolumne River and Newman Wasteway in 1992 and 1993, respectively. Here too, diazinon concentrations in the Tuolumne River may not have been at a maximum for reasons discussed above.

Sources of diazinon in the southern reach of the SJR (below Hills Ferry) contribute at least half of the diazinon mass reported at Vernalis. In February 1992, the Tuolumne River contributed 31% of the load seen at Vernalis. In February 1993, the Newman Wasteway contributed 71% of the load seen at Vernalis. The Merced River was also a consistent source of diazinon. Diazinon is used most heavily in the Merced and Tuolumne River areas (Figures 13 and 14). In addition, peak diazinon loads in the Tuolumne River might not have been measured, as described above for chlorpyrifos.

Methidathion loading in February of 1992 was also lower than in February 1993 (Fig. 12). Methidathion loads were lower than diazinon but higher than chlorpyrifos, related to both amount of use and the physical and chemical properties of the insecticides, as discussed in the Physical-Chemical Properties section of this report. Important sources were Merced River in 1992, and Orestimba Creek, Newman Wasteway, and Tuolumne River in 1993. Methidathion use is highest in the Merced and Tuolumne River areas (Figures 15 and 16).

It appears that all three insecticides are transported conservatively through the watershed, since mass loads were additive to within +/- 30% (Fig. 12). In the February 1993 storm, transport of chlorpyrifos, diazinon, and methidathion from the study area into the Delta was 0.01, 0.08, and 0.5% of the amount applied between storms in the watershed upstream of Vernalis. This calculation was based on the following time factors and assumptions: (1) it took one hour to collect the water sample, (2) the storm/runoff event occurred over a five day period (February 7 - 11), and (3) the peak concentration measured in this study lasted the entire period of extrapolation.

Important sources of dormant spray insecticides during the Lagrangian surveys were Orestimba Creek and Newman Wasteway on the west-side, and TID #5, the Merced and Tuolumne Rivers on the east side (Fig. 12). The Stanislaus River, although in a region of relatively high use, rarely carried insecticides. Concentrations and mass loads in the Newman Wasteway were generally higher than at other sites even though

use in the area is not (Figures 9,10,13-16). Since this channel carries little or no water from the Delta-Mendota Canal during winter, rain runoff from agricultural areas is not diluted with this source of fresh water. Therefore, when water flows in this channel, it can be a major source of pesticides to the SJR. This area would be ideal for future work on mitigation practices and runoff modeling, since it is a small watershed dominated by agricultural runoff.

Dormant spray use is not as high west of the SJR as on the east. However, smaller drainage basins on the west side provide less dilution water and may therefore have higher concentrations and higher, short-term mass loads than the east. Data collected during February 1993, by Domagalski (1995), indicate some of the highest concentrations found in the watershed were detected in west-side creeks. However, duration of water flow in these creeks is short relative to rivers of the east side and maximum concentrations are short in duration and precede peak discharge (Domagalski, 1995). Therefore, mass loads from the west-side are potentially important during short time periods, while larger east-side tributaries are important over longer periods of time. Lagrangian sampling is useful for identifying major sources of pesticide loads. However, peak loads may go undetected in certain areas of a large watershed that is comprised of tributaries prone to a mix of flash flood and perennial flow.

CONCLUSIONS

Water quality measurements made at TID #5 were consistently poor relative to other sites in the watershed, particularly for DO, EC, and total ammonia. This drain carries municipal waste from a primary treatment plant located upstream of the sampling site. In addition, highest electrical conductivity was measured at sites in the southern portion of the watershed where historical problems with selenium and other salts exist.

A total of nine insecticides and three degradation products were detected during the winters of 1991-92 and 1992-93. Four were detected most frequently: chlorpyrifos, diazinon, methidathion, and carbaryl. Of 108 samples collected during the winters of 1991-92 and 1992-93; 10, 72, 19, and 12% contained chlorpyrifos, diazinon, methidathion and carbaryl, respectively, all used as dormant sprays on stone fruit and nut crops.

During the temporal survey conducted in the SJR at Laird Park, chlorpyrifos did not exceed the acute water quality criterion established by the U.S. EPA. During the Lagrangian survey, this criterion was exceeded at only one site, the Newman Wasteway. Diazinon exceeded the CDFG recommended acute criterion in 19 of 34 samples collected during the temporal survey. In addition, diazinon concentrations exceeded the criterion at 12 of 23 sites sampled during the Lagrangian survey. Corresponding criteria for methidathion and carbaryl have not been recommended.

Due to the potential for diazinon to violate water quality criteria, we recommend management practices be developed to control off-site movement of this insecticide.

Of all insecticides measured, diazinon was detected most frequently. Peak concentrations coincided with rain events and peak discharge. Peak concentrations found in 1992-93 (a wet winter) were higher than those found in 1991-92 (a dry winter) presumably because in wet years there is greater runoff potential from saturated soils.

Mass loading calculations indicate chlorpyrifos, diazinon, and methidation were transported conservatively through the watershed. In the February 1993 storm, transport of chlorpyrifos, diazinon, and methidathion from the study area into the Delta was 0.01, 0.08, and 0.5% of the amount applied between storms in the watershed upstream of Vernalis.

Lagrangian surveys were useful for identifying tributaries contributing insecticide loads to the SJR. The Newman Wasteway, Orestimba Creek, and Merced and Tuolumne Rivers were major contributors during these surveys. However, a Lagrangian sampling strategy may not be ideal for determining peak loads in all tributaries when a watershed is a mix of large rivers and small creeks prone to flash flooding. However, it is still useful for identifying major sources of contaminants. In addition, these surveys help focus future work on drainages seen to carry high or consistent insecticide loads in a watershed.

References

Anderson, S.W., T.C. Hunter, and J.R. Mullen. 1990. Water Resources Data, California, Water Year 1989. Vol. 3. U.S. Geological Survey Water-data Report CA-89-1. Sacramento, Ca.

Buchanan, T.J. and W.P. Somers. 1969. Discharge measurements at gaging stations. In: Techniques of Water-Resources Investigations of the United States Geological Survey. Book 3, Chap. A8. 65 p.

Burke, J.A. 1978. The interlaboratory study in pesticide residue analysis. In: H. Geissbuhler, ed. Advances in Pesticide Science, Part 3. IUPAC, Zurich. Pergamon Press, New York.

Central Valley Regional Water Quality Control Board. 1988. Agricultural drainage contribution to water quality in the grassland area of western Merced County, California. Sacramento, CA.

Central Valley Regional Water Quality Control Board. 1989. Water diversion and discharge points along the Tuolumne River: Highway 99 bridge to the San Joaquin River. Report, CVRWQCB, Sacramento.

Central Valley Regional Water Quality Control Board. 1994. Water Quality Control Plan (Basin Plan), Central Valley Region, Sacramento River and San Joaquin River Basins. Sacramento, CA.

Connell, D.E. and G.J. Miller. 1984. Chemistry and Ecotoxicology of Pollution. John Wiley & Sons, New York.

Connor, V. 1988. Survey Results of the San Joaquin River Watershed Survey. CVRWQCB Memorandum dated March 10, 1988.

Department of Pesticide Regulation. 1991. Pesticide use report. Sacramento, CA.

Department of Pesticide Regulation. 1992. Pesticide use report. Sacramento, CA.

Department of Pesticide Regulation. 1993. Pesticide use report. Sacramento, CA.

Domagalski, J.L. 1995. Nonpoint sources of pesticides in the San Joaquin River, California: Input from winter storms, 1992-93. U.S. Geological Survey Open-File Report 95-165.

Fishman, M. and L. Friedman. 1989. Methods for determination of inorganic substances in water and fluvial sediments. Techniques of water-resources investigations of the U.S. Geological Survey, Book 5, p.443.

Foe, C. and V. Connor. 1991. San Joaquin Watershed Bioassay Results, 1988-90. CVRWQCB Report, July 1991.

Glotfelty, D.E., J.N. Seiber, and L.A. Liljedahl. 1987. Pesticides and in fog. Nature 325:602-605.

Glotfelty, D.E., C.J. Schomburg, M.M McChesney, J.C. Sagebiel, and J.N. Seiber. 1990. Studies of the distribution, drift, and volatilization of diazinon resulting from spray application to a dormant peach orchard. Chemosphere 21:1303-1314.

Goldman, C.R. and A.J. Horne. 1983. Limnology. McGraw-Hill, Inc., New York.

Guy, H.P. and V.W. Norman. 1970. Field methods for measurement of fluvial sediment. In: Techniques of Water-Resources Investigations of the United States Geological Survey, Book 3, Chapter C2, 59 p.

Hanor, J.S. 1988. Effects of discharge of municipal waste on water quality of the lower Mississippi River. Environ. Geol. Water Sci. 12(3):163-175.

Hillel, D. 1982. Introduction to Soil Physics. Academic Press Inc., San Diego.

Horwitz, W. 1978. The inevitability of variability in pesticide residue analysis. In: H. Geissbuhler, ed. Advances in Pesticide Science, Part 3. IUPAC, Zurich. Pergamon Press, New York.

Kuivila, K.M. and C.G. Foe. 1995. Concentrations, transport and biological effects of dormant spray pesticides in the San Francisco estuary, California. Environ. Toxicol. Chem. 14(7): 1141-1150.

MacCoy, D., K.L. Crepeau, and K.M. Kuivila. 1995. Dissolved pesticide data for the San Joaquin River at Vernalis and the Sacramento River at Sacramento, California, 1991-94. U.S. Geological Survey Open-File Report 95-110.

Marshack, J.B. 1993. A compilation of water quality goals. CVRWQCB Staff Report, May 1993.

Meade, R.H. and H.H. Stevens. 1990. Strategies and equipment for sampling suspended sediment and associated toxic chemicals in large rivers - with emphasis on the Mississippi River. Sci. Tot. Environ. 97/98:125-135.

Menconi, M. and C. Cox. 1994. Hazard assessment of the insecticide diazinon to aquatic organisms in the Sacramento-San Joaquin River system. California Dept. of Fish and Game, Rancho Cordova. Admin. Report No. 94-2.

Menconi, M. and A. Paul. 1994. Hazard assessment of the insecticide chlorpyrifos to aquatic organisms in the Sacramento-San Joaquin River system. California Dept. of Fish and Game, Rancho Cordova. Admin. Report No. 94-1.

Menconi, M. and S. Siepmann. 1996. Hazard assessment of the insecticide methidathion to aquatic organisms in the Sacramento-San Joaquin River system. California Dept. of Fish and Game, Rancho Cordova. Admin. Report No. 96-1.

Miller, J.C. and J.N Miller. 1988. Statistics for analytical chemistry. 2nd ed. Ellis Horwood Limited. Chichestier, West Sussex.

Rasmussen, D. 1995. Toxic Substances Monitoring Program 1992-93. State Water Resources Control Board, Sacramento. Report # 95-1WQ.

Rasmussen, D. and H. Blethrow. 1990. Toxic Substances Monitoring Program, Ten year summary report 1978-1987. State Water ResourcesControl Board Report # 90-1WQ.

Rosenberg, D.M. and A.P. Wiens. 1978. Effects of sediment addition on macrobiotic invertebrates in a northern Canadian river. Water Research 12:753-763.

Ross, L.J. 1996. Reducing diazinon runoff in almond orchards during winter applications. In preparation. California Department of Pesticide Regulation, Sacramento.

Seiber, J.N., B.W. Wilson, and M.M. McChesney. 1993. Air and fog deposition residues of four organophosphate insecticides used on dormant orchards in the San Joaquin Valley, California. Environ. Sci. Technol. 27:2236-2243.

Shelton, L.R. and L.K. Miller. 1988. Water Quality Data, San Joaquin Valley, California. March 1985 to March 1987. U.S. Geological Survey Open-file Report 88-479. Sacramento, Ca.

Sokal, R.R. and F.J. Rohlf. 1973. Introduction to Biostatistics. W.H. Freeman & Co. San Francisco, CA.

Tchobanoglous G. and E.D. Schroeder. 1985. Water Quality. Addison-Wesley Publishing Co., Menlo Park.

Turner, B., S. Powell, N. Miller, and J. Melvin. 1989. A field study of fog and dry deposition as sources of inadvertent pesticide residues on row crops. California Dept. of Pesticide Regulation, Environmental Hazards Assessment Program, Sacramento, CA. Report No. EH 89-11.

U.S. Environmental Protection Agency. 1986. Quality criteria for water 1986. EPA 440/5-86-001.

U.S. Environmental Protection Agency. 1987. Quality criteria for water 1986, Update #2. EPA 440/5-86-001.

White, D.S. and J.R. Gammon. 1976. The effect of suspended solids on macroinvertebrate drift in an Indiana Creek. Proc. of the Indiana Academy of Sci. 86:182-188.

Zabik, J.M. and J.N. Seiber. 1993. Atmospheric transport of organophosphate pesticides from California's central valley to the Sierra Nevada mountains. J. Environ. Qual. 22:80-90.

Table 1. Number, name, and location of sites used in the San Joaquin River (SJR) study.

Site #	Site Name	Site Description, Latitude and Longitude Coordinates (deg min sec)
1	SJR near Stevinson @ Highway 165	1 mi. S. Hwy 140 & Hwy 165 intersection 37 17 44 120 50 60
2	Salt Slough @ Highway 165	37 14 52 120 51 04
18	SJR @ Fremont Ford	37 18 37 120 55 46
3	Mud Slough	U.S.G.S. gaging station in Kesterson National Wildlife Refuge 37 16 33 120 55 11
4	Los Banos Creek @ Highway 140	Intersection with Highway 140 37 16 36 120 57 16
5	Newman Wasteway	Behind the city of Newman waste water treatment facility 37 19 17 120 58 52
20	Merced River @ Oakdale Rd.	37 27 08 120 35 42
21	Livingston Spillway	2 mi. from Livingston via the Livingston-Cressey Rd. 37 24 14 120 43 16
22	Stevinson Spillway	U.S.G.S. gaging station at end of Faith Home Rd. 37 22 08 120 55 43
23	Highline Spillway	East of terminus of Williams Ave. 37 23 15 120 48 13
24	Merced River @ McConnel State Recreation Area	37 24 56 120 42 33
6	Merced River @ Hatfield State Recreation Area.	37 21 01 120 57 40
7	SJR @ Hills Ferry Rd.	37 20 58 120 58 31
8	Orestimba Creek @ River Rd.	37 24 52 121 00 49
19	Spanish Grant Drain	Down slope from the intersection of Marshall and River Rds. 37 26 08 121 01 56
9	TID #5	Turlock Irrgiation District Drain #5 at Carpenter Rd. 37 27 52 121 01 48
10	SJR @ W. Main St.	37 29 39 121 04 46
11	Del Puerto Creek	North of terminus of Loquat Ave. 37 32 21 121 07 14
12	SJR @ Laird Park	37 33 42 121 09 06
13	Tuolumne River @ Shiloh Rd.	37 36 12 121 07 50
14	Ingram/Hospital Creek	S.E. of Dairy and Pelican Rd. 37 36 57 121 12 15
15	SJR @ Maze Blvd.	37 38 27 121 13 40
16	Stanislaus River @ Caswell Memorial State Park	37 41 43 121 12 10
17	SJR near Vernalis @ Airport Rd.	37 40 33 121 15 51

Table 2. Method detection limits (µg/L) for pesticides and degradation products analyzed in the organophosphate, carbamate, and endosulfan screens in the 1991-92 and 1992-93 winter seasons.

Organophosphates	mdl[a]	Carbamates	mdl	Endosulfan	mdl
Azinphos-methyl	0.05	Aldicarb	0.05	I	0.005
Azinphos-methyl OA[b]	0.30	sulfoxide	0.05	II	0.005
Chlorpyrifos	0.05	sulfone	0.05	sulfate	0.010
Chlorpyrifos OA	0.05	Carbaryl	0.05		
DDVP	0.05	Carbofuran	0.05		
Diazinon[c]	0.05	3-Hydroxy	0.05		
Diazinon OA[c]	0.05	Methiocarb	0.05		
Dimethoate	0.05	Methomyl	0.05		
Ethoprop[d]	0.05	Oxamyl	0.05		
Ethyl parathion	0.05				
Ethyl parathion OA	0.05				
Fonofos[d]	0.05				
Malathion	0.05				
Malathion OA	0.05				
Methidathion	0.05				
Methidathion OA	0.05				
Methyl parathion	0.05				
Methyl parathion OA	0.05				
Phorate	0.05				
Phosalone	0.05				
Phosalone OA	0.05				
Phosmet	0.05				
Phosmet OA	0.30				

a. mdl = method detection limit.
b. OA = oxygen analog.
c. Diazinon and diazinon OA were analyzed with endosulfan. See text for explanation.
d. Only analyzed in the 1992-93 season.

Table 3. Application of chlorpyrifos, diazinon, methidathion and parathion (lbs) in Merced and Stanislaus counties during the dormant spray seasons of 1991-92 and 1992-93.

County/Date	Chlorpyrifos	Diazinon	Methidathion	Parathion
Merced County				
December 1991	2,840	3,100	1,310	16,510
January 1992	10,430	25,920	6,170	1,040
February 1992	4,410	10,790	7	13
Stanislaus County				
December 1991	2,310	3,000	5,470	14,200
January 1992	20,150	29,540	11,380	576
February 1992	3,220	4,370	NRU[a]	190
Merced County				
December 1992	1,270	1,210	1,180	NRU
January 1993	12,570	12,790	2,780	NRU
February 1993	4,980	10,670	761	NRU
Stanislaus County				
December 1992	2,910	3,880	3,700	NRU
January 1993	7,470	31,090	5,710	NRU
February 1993	2,690	17,840	2,360	NRU

a. NRU = no reported use

Table 4. Chlorpyrifos, diazinon, and methidathion applications to crops during the 1991-92 winter season.[a]

Crop	Chlorpyrifos	Diazinon	Methidathion
	---------- lbs ----------		
alfalfa	2,540	119	0
almond	31,330	63,740	18,310
apple	2,970	2,120	421
apricot	0	3,490	145
cherry	180	560	41
nectarine	220	76	18
peach	3,150	1,910	5,000
pear	4	0	12
plum	0	245	22
prune	50	873	192
spinach	0	264	0
swiss chard	0	4	0
walnut	13	18	128

a. Pesticide use data summarized from December 1991 through February 1992 for Merced and Stanislaus counties.

Table 5. Results of continuing quality control (QC) samples during the San Joaquin River winter 1991-92 and 1992-93 seasons.

Analyte	QC Samples Analyzed 1991-92			QC Samples Analyzed 1992-93			Overall	Overall	Overall
	Total	High[a]	Low[b]	Total	High[a]	Low[b]	Total	High[a]	Low[b]
Organophosphate Screen									
Azinphos methyl	13	1	0	13	4	0	26	5	0
Azinphos methyl OA	3	1	0	3	0	1	6	1	1
Chlorpyrifos	13	1	0	13	3	0	26	4	0
Chlorpyrifos OA	6	0	0	4	0	0	10	0	0
DDVP	13	0	0	13	0	0	26	0	0
Diazinon	9	0	0	13	0	0	22	0	0
Diazinon OA	4	0	0	5	0	0	9	0	0
Dimethoate	13	0	0	13	0	0	26	0	0
Ethoprop[c]				1	0	0	1	0	0
Ethyl parathion	6	0	1	5	0	0	11	0	1
Ethyl parathion OA	5	1	0	4	0	0	9	1	0
Fonofos[c]				1	0	0	1	0	0
Malathion	13	0	0	13	2	1	26	2	1
Malathion OA	4	0	0	5	0	0	9	0	0
Methidathion	13	0	0	13	0	0	26	0	0
Methidathion OA	5	1	0	4	0	0	9	1	0
Methyl parathion	13	0	0	13	0	0	26	0	0
Methyl parathion OA	5	0	0	4	0	0	9	0	0
Phorate	6	0	0	4	0	0	10	0	0
Phosalone	6	0	0	5	0	0	11	0	0
Phosalone OA	3	0	0	4	0	0	7	0	0
Phosmet	13	0	0	13	2	1	26	2	1
Phosmet OA	3	0	0	5	0	0	8	0	0
Total	169	5	1	171	11	3	340	16	4
Carbamate Screen									
Aldicarb	13	0	0	16	0	0	29	0	0
Aldicarb sulfoxide	13	5	0	16	1	0	29	6	0
Aldicarb sulfone	12	1	0	21	0	1	33	1	1
Carbaryl	13	0	0	16	0	0	29	0	0
Carbofuran	12	0	0	21	0	2	33	0	2
Carbofuran 3-Hydroxy	12	0	0	21	0	0	33	0	0
Methiocarb	12	0	0	21	0	1	33	0	1
Methomyl	12	0	0	20	0	0	32	0	0
Oxamyl	13	0	0	16	0	0	29	0	0
Total	112	6	0	168	1	4	280	7	4
Endosulfan Screen									
Diazinon	17	5	0	16	0	0	33	5	0
Diazinon OA	17	1	0	16	0	0	33	1	0
Endosulfan I	17	2	0	16	0	0	33	2	0
Endosulfan II	17	0	0	16	0	0	33	0	0
Endosulfan sulfate	17	0	0	16	0	0	33	0	0
Total	85	8	0	80	0	0	165	8	0

a. Continuing quality control sample result was above the upper control limit (see Appendix II and III).
b. Continuing quality control sample result was below the lower control limt (see Appendix II and III).
c. Analyte not analyzed in the 1991-92 winter season.

Table 6. Acute water quality objectives and criteria for the protection of freshwater aquatic life.

Constituent	CVRWQCB Objectives[a]	U.S. EPA Criteria[b]	CDFG Suggested Criteria[c]
pH	6.5 - 8.5	6.5 - 9.0	NA[d]
Dissolved Oxygen[e]	5.0 mg/L (warm) 8.0 mg/L (cold)	5.0 mg/L (warm) 7.0 mg/L (cold) 7.0 mg/L (spwn)	NA
Electrical Conductivity	NA	NA	NA
Total Ammonia[f]	NA	0.009 - 35 mg/L	NA
Chlorpyrifos	NA	0.083 µg/L	NA[g]
Diazinon	NA	NA	0.08 µg/L
Fonofos	NA	NA	NA
Methidathion	NA	NA	NA[h]
Phosmet	NA	NA	NA
Carbaryl	NA	NA	NA
Carbofuran	0.40 µg/L	NA	NA[h]
Endosulfan (Total)	NA	0.22 µg/L	NA

a. Objectives are from: Central Valley Regional Water Quality Control Board. 1994. Water Quality Control Plan (Basin Plan), Central Valley Region, Sacramento and San Joaquin River Basins. Third Edition. Sacramento, CA

b. Criteria are from: United States Environmental Protection Agency. 1986. Quality criteria for water 1986, and Quality criteria for water 1986, Update #2. EPA 440/5-86-001.

c. California Department of Fish and Game's suggested criteria, see Menconi and Cox, 1994 for diazinon hazard assessment.

d. Not available.

e. Dissolved oxygen objectives and criteria are dependent on habitat type (warm, cold, or spawning habitat).

f. Total ammonia criteria are dependent on temperature and pH and therefore have a wide range in values.

g. The suggested criterion in CDFG's chlorpyrifos hazard assessment (Menconi and Paul, 1994) was a combined fresh and salt water value. In discussions among staff from CVRWQCB, DPR, and CDFG, it was decided that CDFG would develop a separate fresh water criterion, in accordance with U.S. EPA methods.

h. Due to a lack of data, CDFG could not develop criteria for methidathion and carbofuran using accepted U.S. EPA methods (Menconi and Siepmann, 1996).

Table 7. Principal component analysis of water quality measurements made during the Lagrangian surveys in the winters of 1991-92 and 1992-93.

Simple Statistics

	Water Temp (°C)	pH	DO[a] (mg/L)	EC[b] (uS/cm)	Ammonia (mg/L)	Discharge (cfs)	TSS[c] (mg/L)	TOC[d] (mg/L)
Mean	11.4	7.2	8.2	1110	1.5	1006	135	16.7
Standard Deviation	1.60	0.49	1.9	1120	2.3	1477	106	28.4

Correlation Matrix

	Water Temp	pH	DO	EC	Ammonia	Discharge	TSS	TOC
Water Temp	1.00							
pH	-.062	1.00						
DO	-.60	0.33	1.00					
EC	0.0065	0.58	0.24	1.00				
Ammonia	0.52	0.07	-.68	0.063	1.00			
Discharge	-.051	-.35	-.11	-.39	-.10	1.00		
TSS	0.28	-.36	-.42	-.30	0.20	0.25	1.00	
TOC	0.48	0.03	-.60	0.069	0.69	-.046	0.35	1.00

Eigenvalues of the Correlation Matrix

	Eigenvalues	Proportion[e]	Cumulative[f]	
Principal Component 1	3.064	0.383	0.383	
Principal Component 2	2.108	0.263	0.646	
Principal Component 3	0.717	0.090	0.736	
Principal Component 4	0.654	0.082	0.818	

Eigenvector Loadings

	Prin. Comp. 1	Prin. Comp. 2	Prin. Comp. 3	Prin. Comp. 4
Water Temp	0.4104	0.1737	-.1874	-.0684
pH	-.1908	0.5224	0.4030	-.0281
DO	-.5134	0.0039	0.1570	0.1821
EC	-.1507	0.5358	0.2994	0.1770
Ammonia	0.4365	0.2922	0.0258	-.2864
Discharge	0.0878	-.4539	0.7409	-.4328
TSS	0.3433	-.2432	0.2836	0.8104
TOC	0.4391	0.2436	0.2412	0.0630

a. Dissolved oxygen
b. Electrical Conductivity
c. Total suspended sediment
d. Total organic carbon
e. Proportion of variability explained by principal component.
f. Cumulative proportion of variability explained by the component.

Table 8. Temporal variation in insecticide concentrations (µg/L) in water collected from the San Joaquin River at Laird Park (site 12) during the 1991-92 and 1992-93 dormant spray season.

			Endosulfan[a]		
Date	Organophosphates[a]	Carbamates[a]	I	II	sulfate
12-23-91	ND[b]	ND	ND	ND	ND
12-26-91	ND	ND	ND	ND	ND
12-30-91	ND	ND	ND	ND	ND
01-02-92	ND	ND	ND	ND	ND
01-06-92	ND	ND	ND	ND	ND
01-13-92	ND, c	ND	ND	ND	ND
01-16-92	ND	ND, d	ND	ND	ND
01-20-92	Diazinon 0.07 Methidathion 0.07	ND	ND	ND	ND
01-23-92	Diazinon 0.10	ND	ND	ND	ND
01-30-92	See Lagrangian survey results in Table 9.				
02-03-92	Diazinon 0.08	ND	ND	ND	ND
02-06-92	Diazinon 0.09	ND	ND	ND	ND
02-10-92	Diazinon 0.12	ND	ND	ND	ND
02-13-92	Diazinon 0.35 Methidathion 0.16	ND	ND	ND	ND
02-19-92	See Lagrangian survey results in Table 9.				
02-24-92	Diazinon 0.08	ND	ND	ND	ND
02-27-92	Diazinon 0.06	ND	ND	ND	ND
12-29-92	ND, e	ND	ND	ND	ND
01-04-93	ND	ND	ND	ND	ND
01-07-93	Diazinon 0.08, f	ND, g	ND	ND	ND
01-11-93	Diazinon 0.31	ND	ND	ND	ND
01-14-93	Diazinon 1.29	ND, g	ND	ND	ND
01-17-93	See Lagrangian survey results in Table 9.				
01-21-93	Diazinon 0.13	ND	ND	ND	ND
01-25-93	Diazinon 0.14	Carbaryl 0.05	ND	ND	ND
01-28-93	Diazinon 0.11	ND	ND	ND	ND
02-01-93	Diazinon 0.09	ND	ND	ND	ND
02-04-93	Diazinon 0.23	ND	ND	ND	ND

Table 8. (Continued).

Date	Organophosphates[a]	Carbamates[a]	Endosulfan[a]		
			I	II	sulfate
02-10-93	See Lagrangian survey results in Table 9.				
02-11-93	Chlorpyrifos 0.07 Diazinon 1.22 Methidathion 0.33	ND	ND	ND	ND
02-15-93	Diazinon 0.25 Methidathion 0.09	ND	ND	ND	ND
02-18-93	Diazinon 0.16	ND, h	ND	ND	ND
02-22-93	Diazinon 0.13	ND	ND	ND	ND
02-25-93	Diazinon 0.07, i	ND	ND	ND	ND

a. All pesticides in the organophosphate and carbamate screens are listed in Table 2. Diazinon and diazinon oxon were analyzed in the endosulfan sample. See text for explanation.
b. ND = none detected. Method detection limits are listed in Table 2.
c. Companion quality control spike was low for ethyl parathion (see Appendix III).
d. Companion quality control spike was low for aldicarb sulfone.
e. Companion quality control spike was low for phosmet.
f. Companion quality control spike was low for azinphos-methyl OA.
g. Companion quality control spike was low for carbofuran.
h. Companion quality control spike was low for methiocarb.
i. Companion quality control spike was low for malathion.

Table 9. Organophosphates detected in wet and dry deposition collected during the 1992-93 winter season.[a]

Date	Site[b]	Inches Rain[c]	Wet Deposition (µg/L)	Dry Deposition[d]
1/8/93	6	NA[e]	Diazinon 0.09, 0.11[f]	NA
	16	NA	Diazinon 0.88	NA
1/11/93	6	0.45	ND[g]	-
	16	0.32	Diazinon 0.06	-
1/14/93	6	1.45	Diazinon 0.11, 0.09[f]	NA
	16	1.13	Diazinon 0.25	NA
1/17/93	6	0.61	Diazinon 0.15	-
	16	0.82	Diazinon 0.06	-
1/21/93	6	0.80	Diazinon 0.37 D. oxon 0.08	NA
	16	0.98	Chlorpyrifos 0.05 Diazinon 0.53 D. oxon 0.08	NA
1/25/93	6	0		-
	16	0.21	Diazinon 0.10	-
	24	0		Methidathion
2/1/93	6	0		-
	16	0		Diazinon Methidathion
	24	0		Chlorpyrifos Diazinon Methidathion
2/4/93	6	0		NA
	16	0		NA
	24	0		NA
2/8/93	6	1.99	Diazinon 0.53, 0.48[f] D. oxon 0.07	Diazinon D. oxon

Table 9. (Continued).

Date	Site[b]	Inches Rain[c]	Wet Deposition (µg/L)	Dry Deposition[d]
2/8/93	16	1.05	Chlorpyrifos 0.09 Diazinon 1.9 D. oxon 0.12	Diazinon D. oxon
	24	1.17	Chlorpyrifos 0.34 Diazinon 1.53 D. oxon 0.14	-
2/11/93	6	0.31	Diazinon 0.11	NA
	16	0.96	Diazinon 0.62 D. oxon 0.10	NA
	24	0.48	Chlorpyrifos 0.14 Diazinon 1.61 D. oxon 0.22	-
2/15/93	6	0		-
	16	0.01		-
	24	0		-
2/18/93	6	0.37	Diazinon 0.42 D. oxon 0.07	NA
	16	0.35	Diazinon 0.25 D. oxon 0.08	NA
	24	0.36	Diazinon 0.37 D. oxon 0.11	NA
2/22/93	6	0.34	NA	-
	16	1.67	Diazinon 0.33 0.32[f]	-
	24	NA	Chlorpyrifos 0.06 Diazinon 0.26	-
2/25/93	6	0.18	ND[h]	NA
	16	0.04	NA	NA
	24	0.38	Chlropyrifos 0.06 Diazinon 0.19	NA
3/1/93	6	0.48	Diazinon 0.14 D. oxon 0.06	-

Table 9. (Continued).

Date	Site[b]	Inches Rain[c]	Wet Deposition (µg/L)	Dry Deposition[d]
	16	0.72	Diazinon 0.10	-
	24	0.33	Diazinon 0.16 D. oxon 0.06	-

a. See Table 2 for a list of organophosphates and detection limits. Carbamates and endosulfans were also analyzed when enough rain water was available (i.e. > 0.6" and > 1.2" for carbamates and endosulfans, respectively). Carbamate and endosulfan residues were not detected in rain water.
b. Site number and corresponding name and location are listed in Table 1.
c. Inches of rain collected since prior sampling date. Rain gauges were deployed on 1/5/93, 1/5/93, and 1/21/93 for sites 6, 16, and 24, respectively.
d. Dry deposition reported as + or -.
e. Not available.
f. Duplicate samples analyzed by the organophosphate and endosulfan screens. Note, samples were not acidified.
g. None detected.
h. Detection limit was 0.01 µg/L because less than 400 mL was available for analysis.

Table 10. Concentrations (µg/L) of organophosphates, carbamates, and endosulfan in water collected during the Lagrangian surveys conducted in the winter of 1992 and 1993.

Date	Site	Organophosphates[a]	Carbamates[a]	Endosulfan I	Endosulfan II	Endosulfan sulfate
1-27-92	1	Diazinon 0.15	ND[b]	ND	ND	ND
1-27-92	2	ND	ND	ND	ND	ND
1-28-92	18	ND	ND	ND	ND	ND
1-27-92	3	ND	ND	ND	ND	ND
1-27-92	4	ND	ND	ND	ND	ND
1-28-92	5	Diazinon 0.09	ND	ND	ND	ND
1-28-92	6	Diazinon 0.10	ND	ND	ND	ND
1-28-92	7	Diazinon 0.09	ND	ND	ND	ND
1-29-92	8	No water in Orestimba Creek at time of sampling				
1-29-92	9	Diazinon 0.45	Carbaryl 1.0	ND	ND	ND
1-29-92	10	Diazinon 0.08	ND	ND	ND	ND
1-30-92	11	No water in Del Puerto Creek at time of sampling				
1-30-92	12	Diazinon 0.09	ND	ND	ND	ND
1-30-92	13	Diazinon 0.09	ND	ND	ND	ND
1-30-92	14	Diazinon 0.06	ND	ND	ND	ND
1-30-92	15	Diazinon 0.11	ND	ND	ND	ND
1-30-92	16	Diazinon 0.10	ND	ND	ND	ND
1-31-92	17	Diazinon 0.09	ND	ND	ND	ND
2-17-92	1	Diazinon 0.06	ND	ND	ND	ND
2-17-92	2	ND	ND	ND	ND	ND
2-17-92	18	Diazinon 0.05	ND	ND	ND	ND
2-17-92	3	Diazinon 0.06	ND	ND	ND	ND
2-17-92	4	Diazinon 0.06	ND	ND	ND	ND
2-17-92	5	Diazinon 2.14 Ethyl parathion 0.10 Methidathion 0.56	Carbaryl 0.06	ND	ND	0.022

Table 10. (Continued).

Date	Site	Organophosphates[a]	Carbamates[a]	Endosulfan I	Endosulfan II	Endosulfan sulfate
2-18-92	6	Chlorpyrifos 0.06 Diazinon 0.07 Methidathion 0.18	ND	ND	ND	ND
2-18-92	7	Diazinon 0.13	ND	ND	ND	ND
2-18-92	8	Diazinon 0.60 Ethyl parathion 0.05 Methidathion 0.56	ND	ND	ND	ND
2-18-92	9	Diazinon 0.28 Methidathion 0.33	Carbaryl 0.11 Carbofuran 0.12 Aldicarb sulfoxide 0.26	ND	ND	ND
2-19-92	10	Diazinon 0.11 Methidathion 0.07	ND	ND	ND	ND
2-19-92	11	ND	ND	ND	ND	ND
2-19-92	12	Diazinon 0.14 Methidathion 0.07	ND	0.005	0.006	0.023
2-19-92	13	Diazinon 0.22	ND	ND	ND	ND
2-19-92	14	Diazinon 0.20 Methidathion 0.19	ND	ND	ND	ND
2-19-92	15	Diazinon 0.17	ND	ND	ND	ND
2-19-92	16	ND	ND	ND	ND	ND
2-19-92	17	Diazinon 0.15	ND	ND	ND	ND
1-15-93	1	ND	ND	ND	ND	ND
1-15-93	2	ND	ND	ND	ND	ND
1-16-93	18	ND	ND	ND	ND	ND
1-15-93	3	ND	ND, c	ND	ND	ND
1-15-93	4	ND	ND	ND	ND	ND
1-15-93	5	Chlorpyrifos 0.12 Diazinon 0.05	Carbaryl 0.06	ND	ND	ND
1-14-93	20	ND	ND	ND	ND	ND
1-15-93	21	Diazinon 1.03	ND	ND	ND	ND

Table 10. (Continued).

Date	Site	Organophosphates[a]	Carbamates[a]	Endosulfan I	Endosulfan II	Endosulfan sulfate
1-16-93	6	Diazinon 0.08	ND	ND	ND	ND
1-16-93	7	ND	ND	ND	ND	ND
1-16-93	8	ND	ND	ND	ND	ND
1-16-93	19	Diazinon 0.15 Fonofos 0.11, 0.14[d]	ND, c	ND	ND	ND
1-16-93	9	Diazinon 0.12	ND	ND	ND	ND
1-16-93	10	ND	ND	ND	ND	ND
1-16-93	11	ND	ND	ND	ND	ND
1-17-93	12	Diazinon 0.17	ND	ND	ND	ND
1-17-93	13	ND	ND	ND	ND	ND
1-17-93	14	Diazinon 0.12, 0.16[d]	ND	ND	ND	ND
1-17-93	15	Diazinon 0.11, 0.15[d]	ND, c	ND	ND	ND
1-17-93	16	ND	ND, c	ND	ND	ND
1-17-93	17	Diazinon 0.13	ND	ND	ND	ND
2-08-93	1	Diazinon 0.26	ND	ND	ND	ND
2-08-93	2	Diazinon 0.13	ND	ND	ND	ND
2-09-93	18	Diazinon 0.17	ND	ND	ND	ND
2-08-93	3	Diazinon 0.17	ND	ND	ND	ND
2-08-93	4	Diazinon 0.11	ND	ND	ND	ND
2-09-93	5	Chlorpyrifos 0.22, 0.14[d] Diazinon 25.6, 36.8[d] Diazinon oxon 0.70, 0.39[d] Methidathion 9.1, 12.4[d]	ND	ND	ND	ND
2-07-93	20	Chlorpyrifos 0.07	ND	ND	ND	ND
2-08-93	21	Chlorpyrifos 0.10 Diazinon 0.78 Phosmet 3.2	ND	ND	ND	ND
2-09-93	22	Diazinon 1.32 Diazinon oxon 0.08	ND	ND	ND	ND

Table 10. (Continued).

Date	Site	Organophosphates[a]	Carbamates[a]	Endosulfan I	Endosulfan II	Endosulfan sulfate
2-08-93	23	Chlorpyrifos 0.07 Diazinon 2.54 Diazinon oxon 0.21 Methidathion 0.14	Carbaryl 0.07	ND	ND	ND
2-09-93	6	Chlorpyrifos 0.06 Diazinon 0.40	Carbaryl 3.95 3.44[d]	ND	ND	ND
2-09-93	7	Diazinon 1.69 Methidation 0.33	Carbaryl 0.80	ND	ND	ND
2-09-93	8	Diazinon 0.07 Methidathion 2.14	ND	ND	ND	ND
2-09-93	19	Diazinon 0.19	ND	ND	ND	ND
2-09-93	9	Chlorpyrifos 0.07 Diazinon 1.69	Carbaryl 0.83	ND	ND	ND
2-10-93	10	Chlorpyrifos 0.08 Diazinon 1.18 Methidathion 0.76	Carbaryl 0.14	ND	ND	ND
2-10-93	11	ND	ND	ND	ND	ND
2-10-93	12	Chlorpyrifos 0.06 Diazinon 0.77 Methidathion 0.60	Carbaryl 0.26	ND	ND	ND
2-10-93	13	Diazinon 0.18 Methidathion 0.07	ND	ND	ND	ND
2-10-93	14	Diazinon 0.41	ND	ND	ND	ND
2-10-93	15	Diazinon 0.37 Methidathion 0.34	Carbaryl 0.10	ND	ND	ND
2-10-93	16	Diazinon 0.11	ND	ND	ND	ND
2-10-93	17	Diazinon 0.36 Methidathion 0.42	Carbaryl 0.09	ND	ND	ND

a. All pesticides in the organophosphate and carbamate screens are listed in Table 2. Diazinon and diazinon oxon were analyzed with endosulfan. See text for explanation.
b. None detected. Method detection limits are listed in Table 2.
c. Companion quality control spike was low for aldicarb sulfone (see Appendix III).
d. Split sample analyzed.

Table 11. Physical and chemical properties of chlorpyrifos, diazinon, and methidathion. Properties from the Department of Pesticide Regulation Pesticide Chemistry Database (Kollman and Segawa, 1995).

Property	Chlorpyrifos	Diazinon	Methidathion
Solubility (mg/L)	1.39	60.0	221
Hydrolysis Half-life at pH 7 (days)	72.1 (at 25°C)	138 (at 24°C)	41 (at 20°C)
Aerobic Soil Metabolism Half-life (days)	113[a] 57 - 179[b]	39.7	3.1
Soil Adsorption (K_d)	125[a] 69 - 253[b]	14.6	3.97
Field Dissipation Half-life (days)	45.0[a] 33 - 56[b]	14.2[a] 7 - 30[b]	5 (Approx.)

a. Mean reported in Kollman and Segawa, 1995.
b. Range

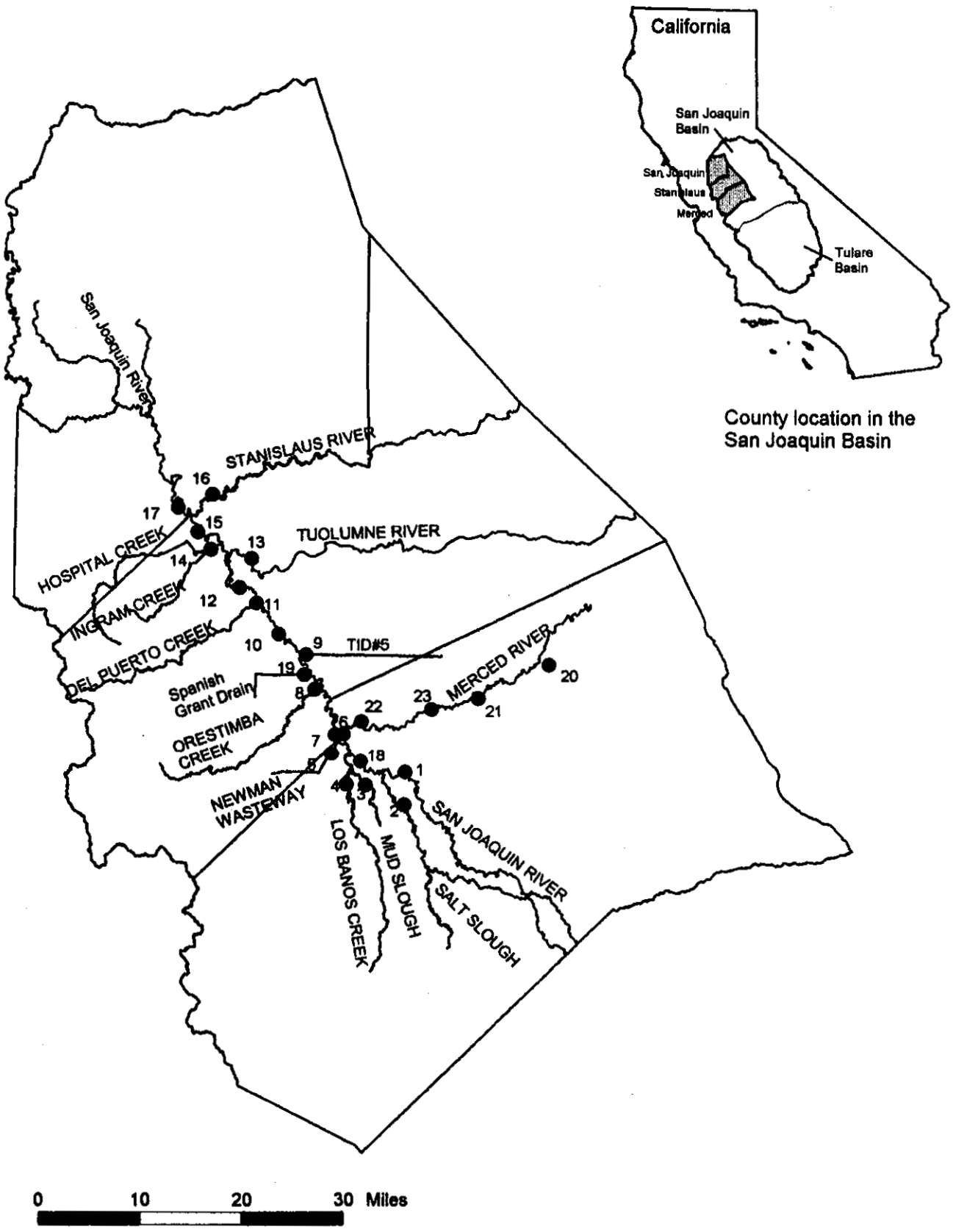


Figure 1. Sampling site locations in the San Joaquin River study area.

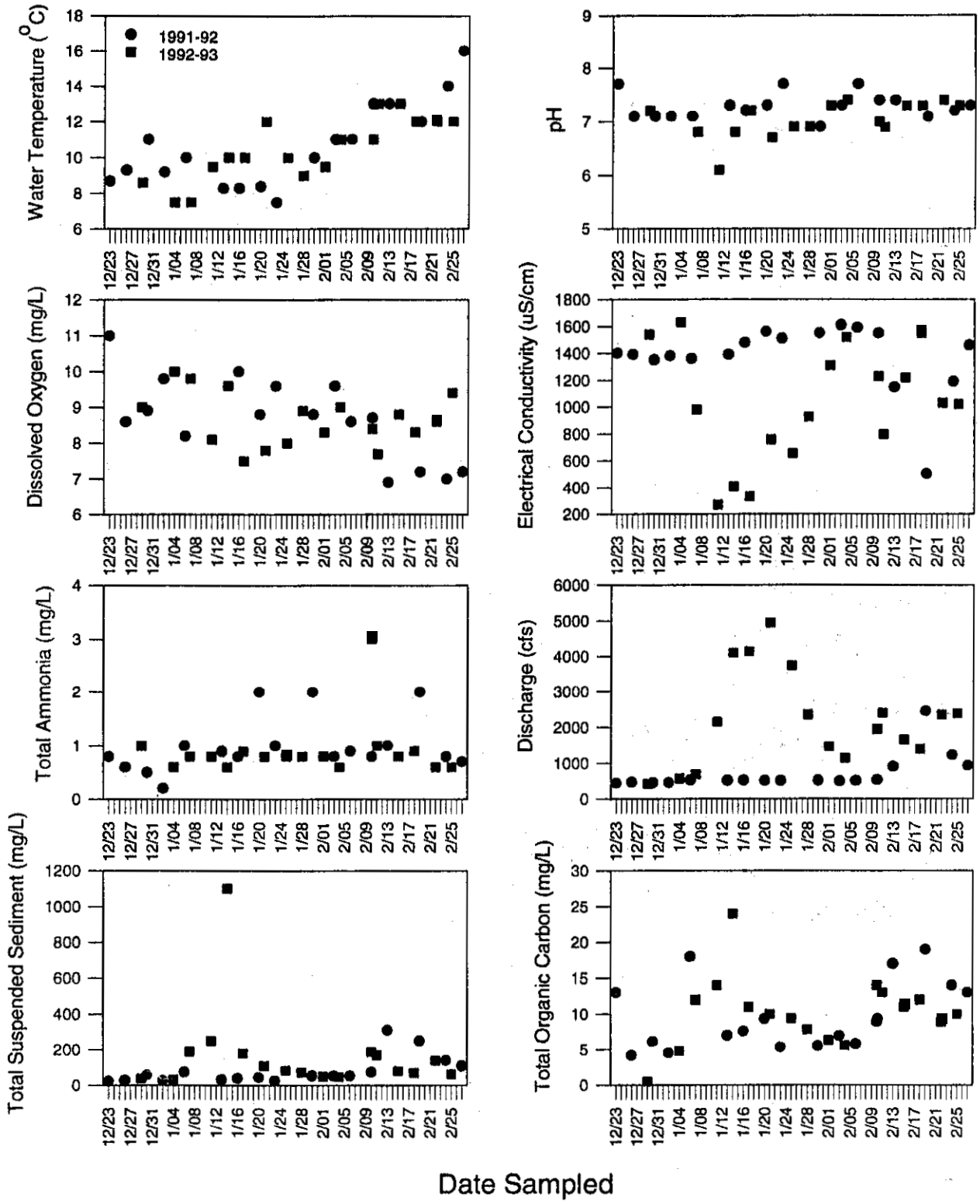


Figure 2. Temporal variation in water quality parameters measured at Laird Park during the winter seasons of 1991-92 and 1992-93.

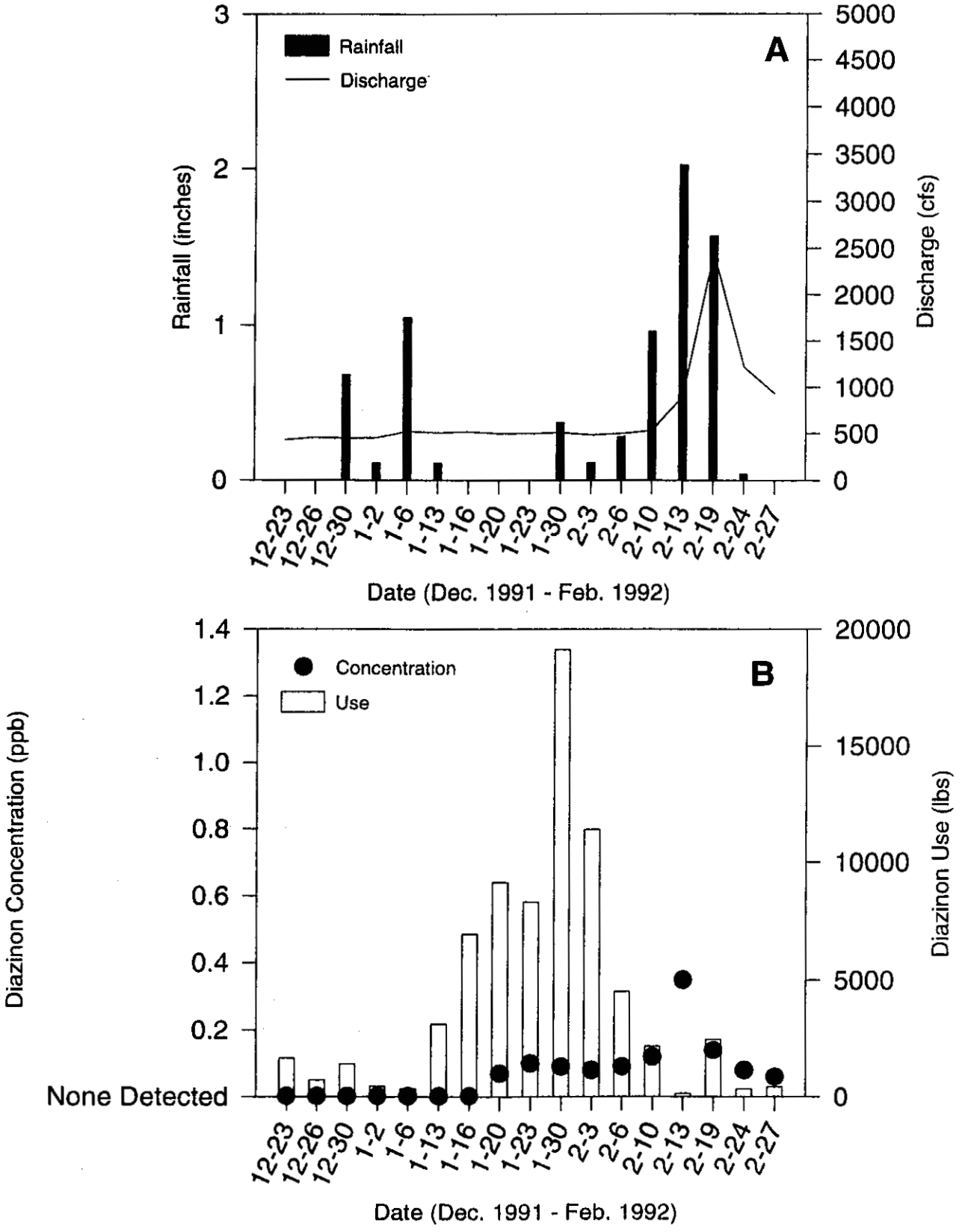


Figure 3. Data collected during the 1991-92 winter season. (A) Rainfall recorded at Modesto and discharge measured at Laird Park (site 12). (B) Diazinon concentrations from Laird Park and use reported in Merced and Stanislaus counties. Rainfall and diazinon use are summed between sampling intervals.

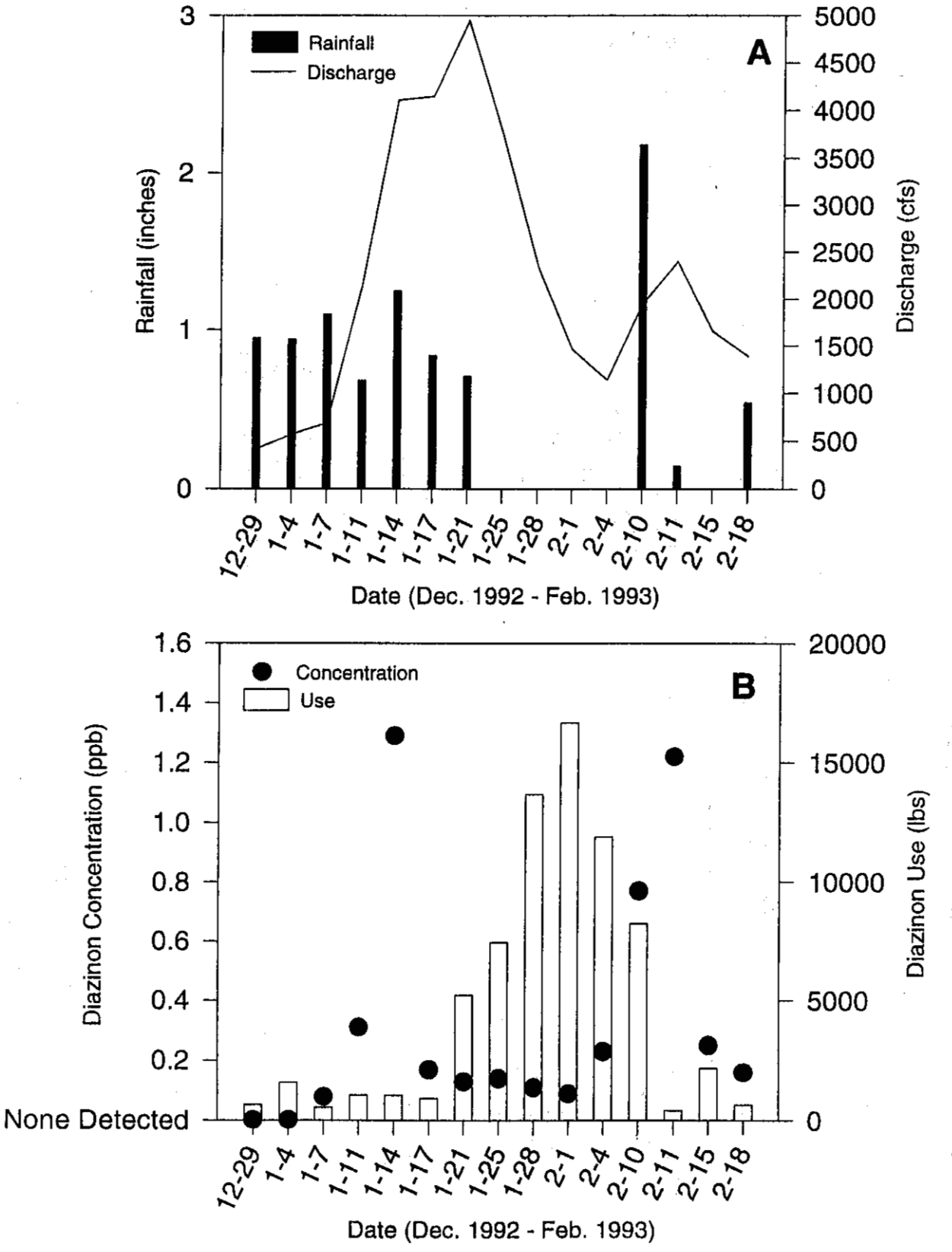


Figure 4. Data collected during the 1992-93 winter season. (A) Rainfall recorded at Modesto and discharge measured at Laird Park (site 12). (B) Diazinon concentrations from Laird Park and use reported in Merced and Stanislaus counties. Rainfall and diazinon use are summed between sampling intervals.

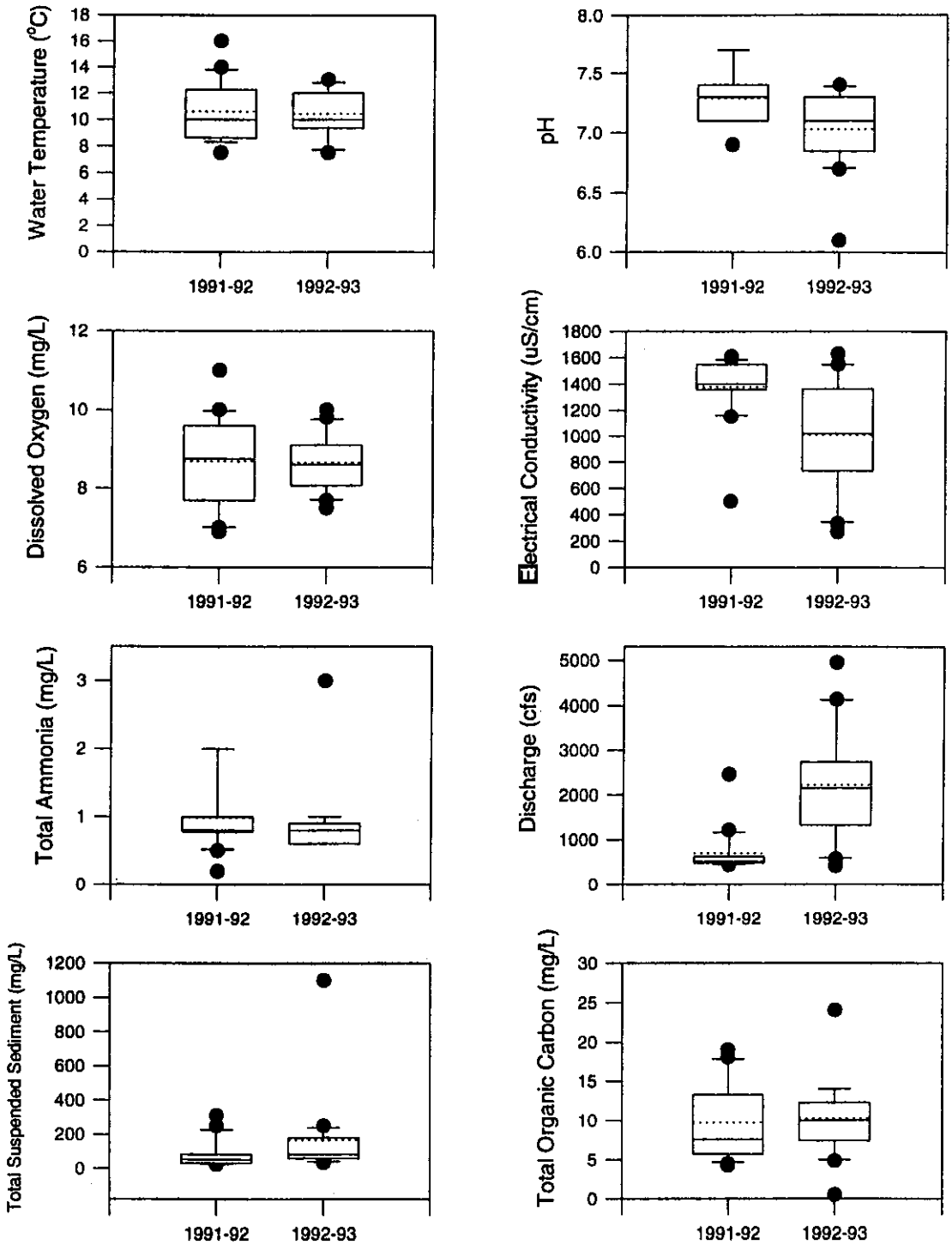


Figure 5. Distribution of water quality measurements from Laird Park during the winter seasons of 1991-92 and 1992-93. Box edges represent the 25th and 75th percentiles, capped bars indicate the 10th and 90th percentiles, circles indicate data falling outside the 10th and 90th percentiles, solid lines indicate the median, and dashed lines indicate the mean.

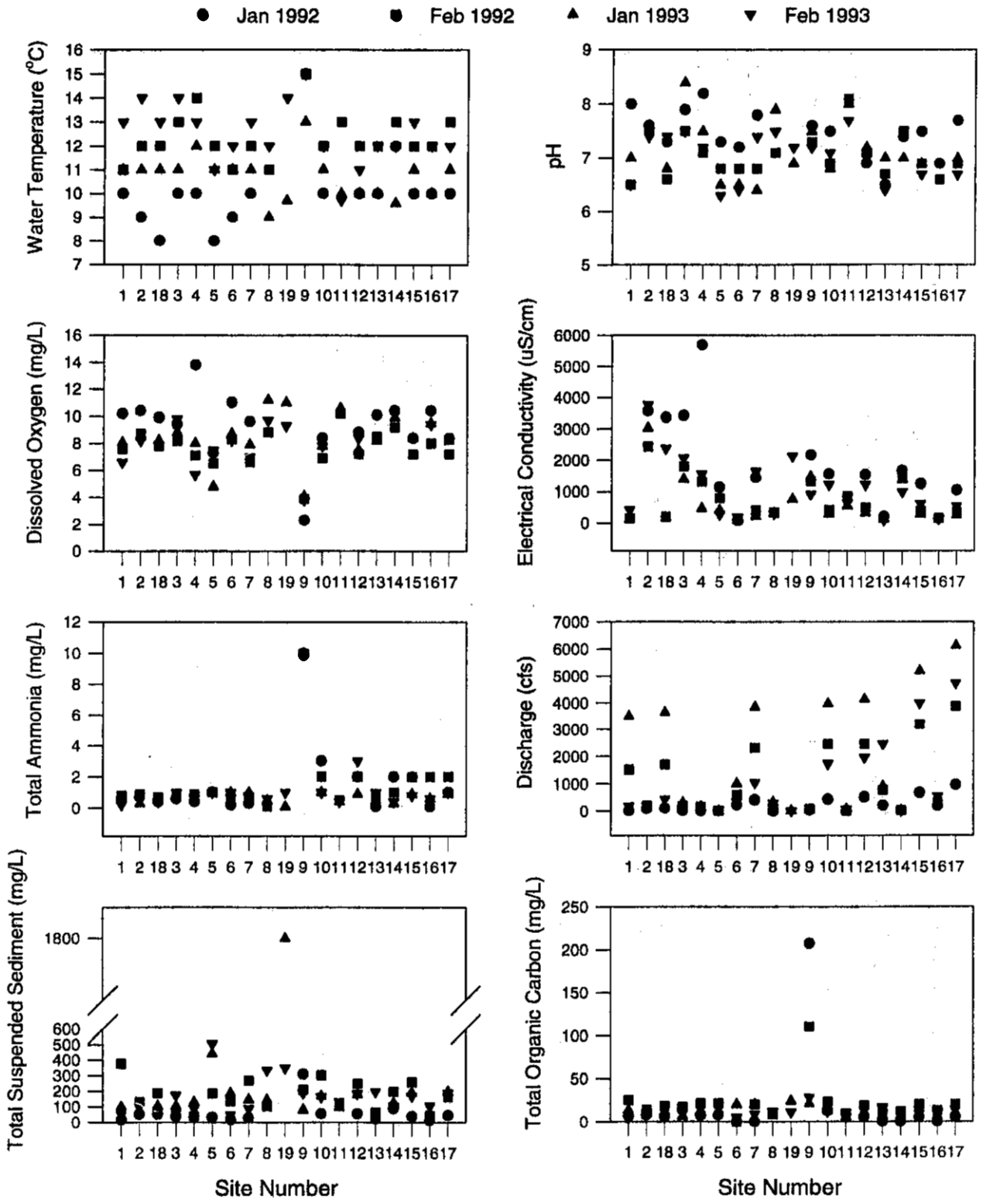


Figure 6. Water quality measurements made in the San Joaquin River watershed during four Lagrangian surveys conducted January 1992, February 1992, January 1993, and February 1993.

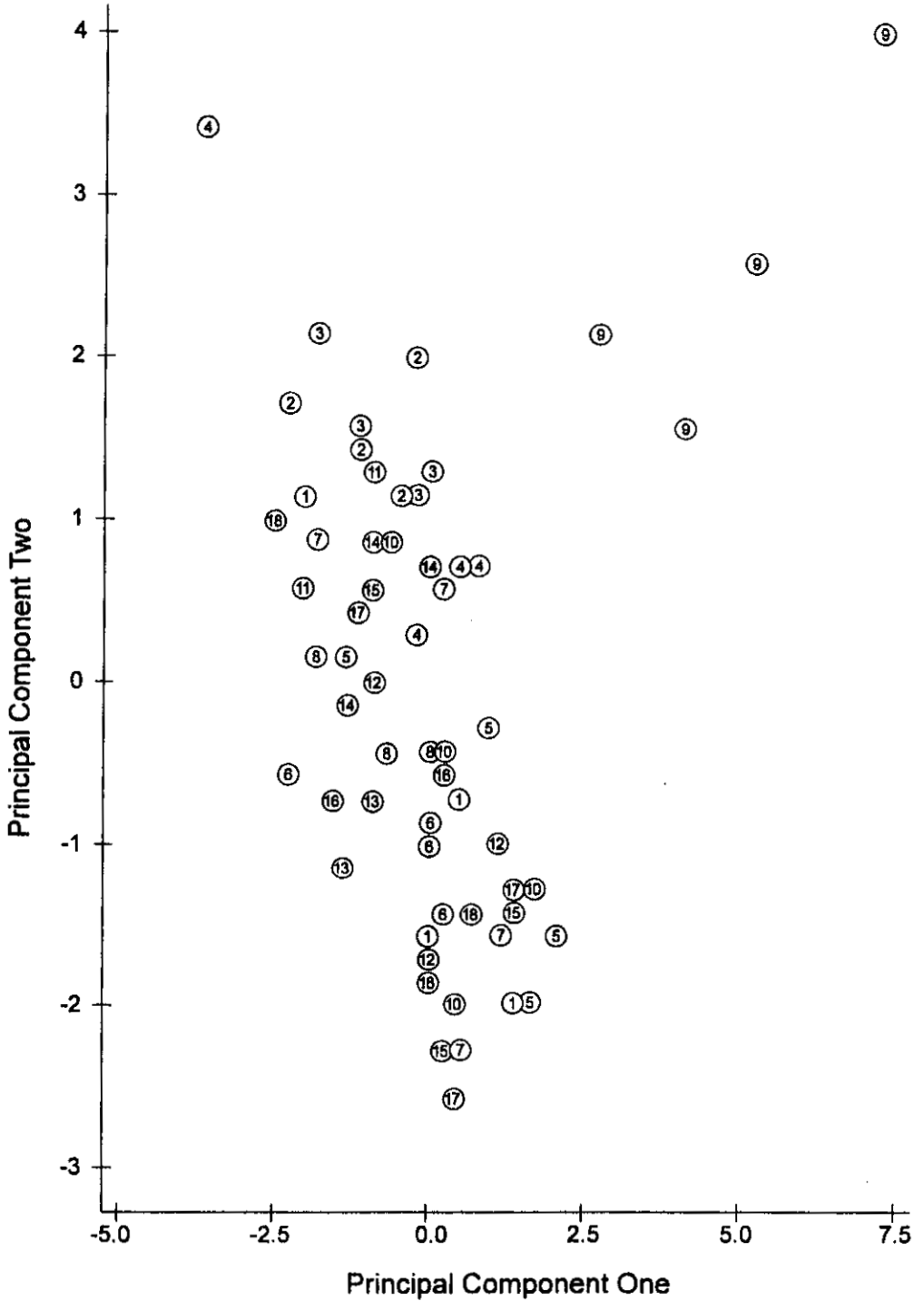


Figure 7. Principal component analysis of water quality measurements made during the Lagrangian surveys conducted in the winters of 1991-92 and 1992-93. Numbers in the plot represent site numbers (see Table 1 for site number description). Note: nine observations had missing values and three observations are hidden.

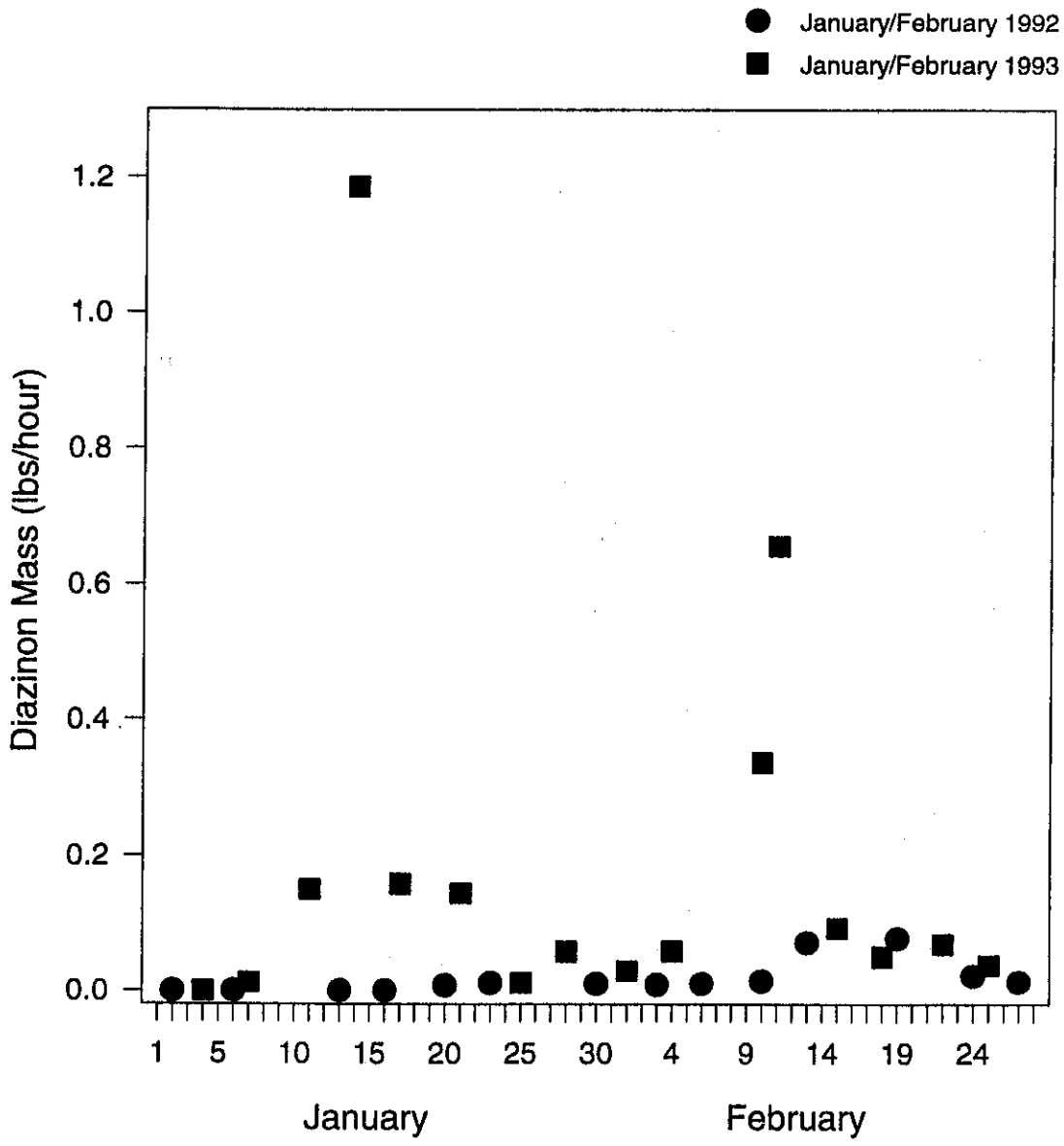


Figure 8. Diazinon mass loads in the San Joaquin River at Laird Park during January and February of 1992 and 1993.

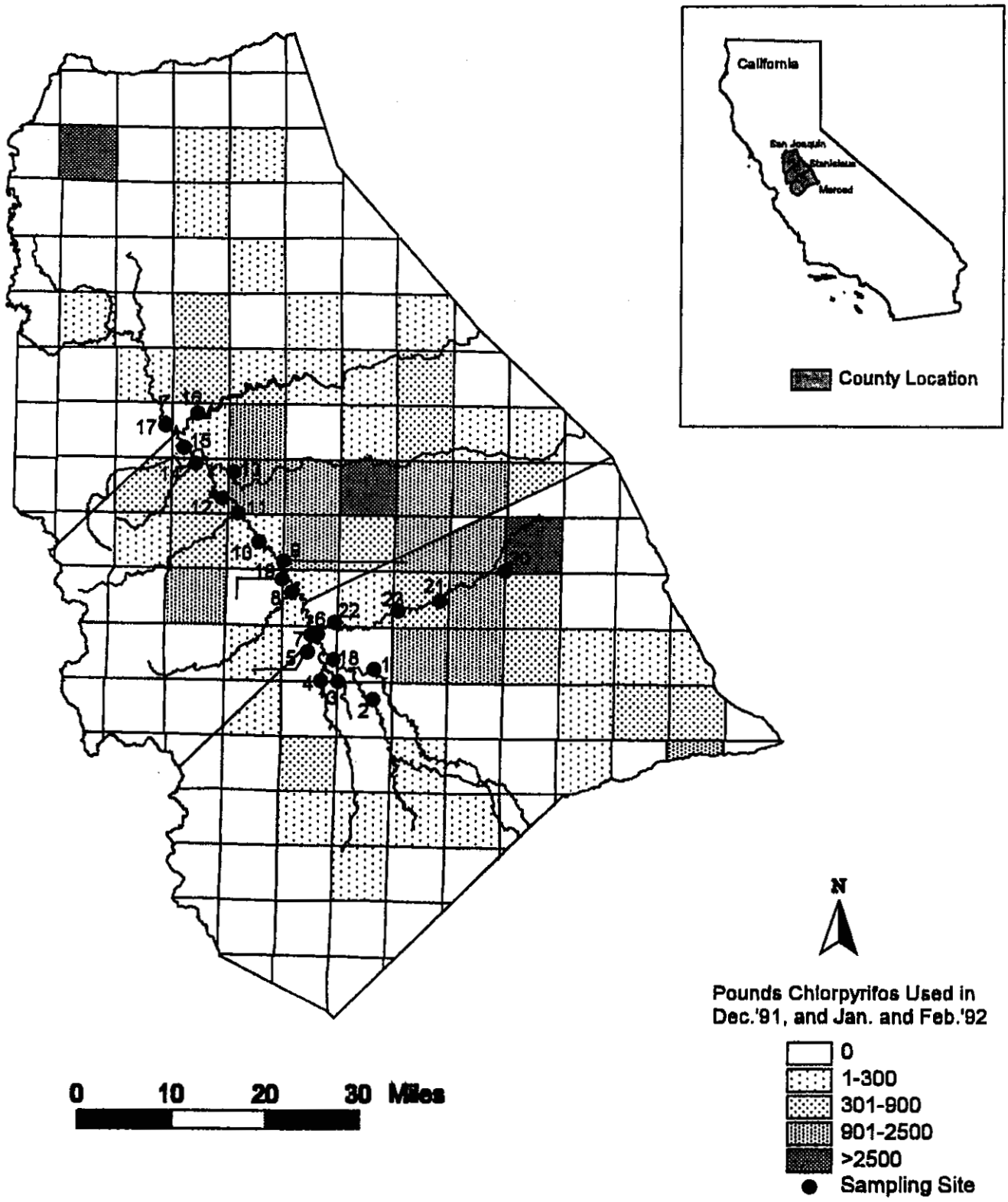


Figure 9. Chlorpyrifos use during the 1991-92 dormant spray season.

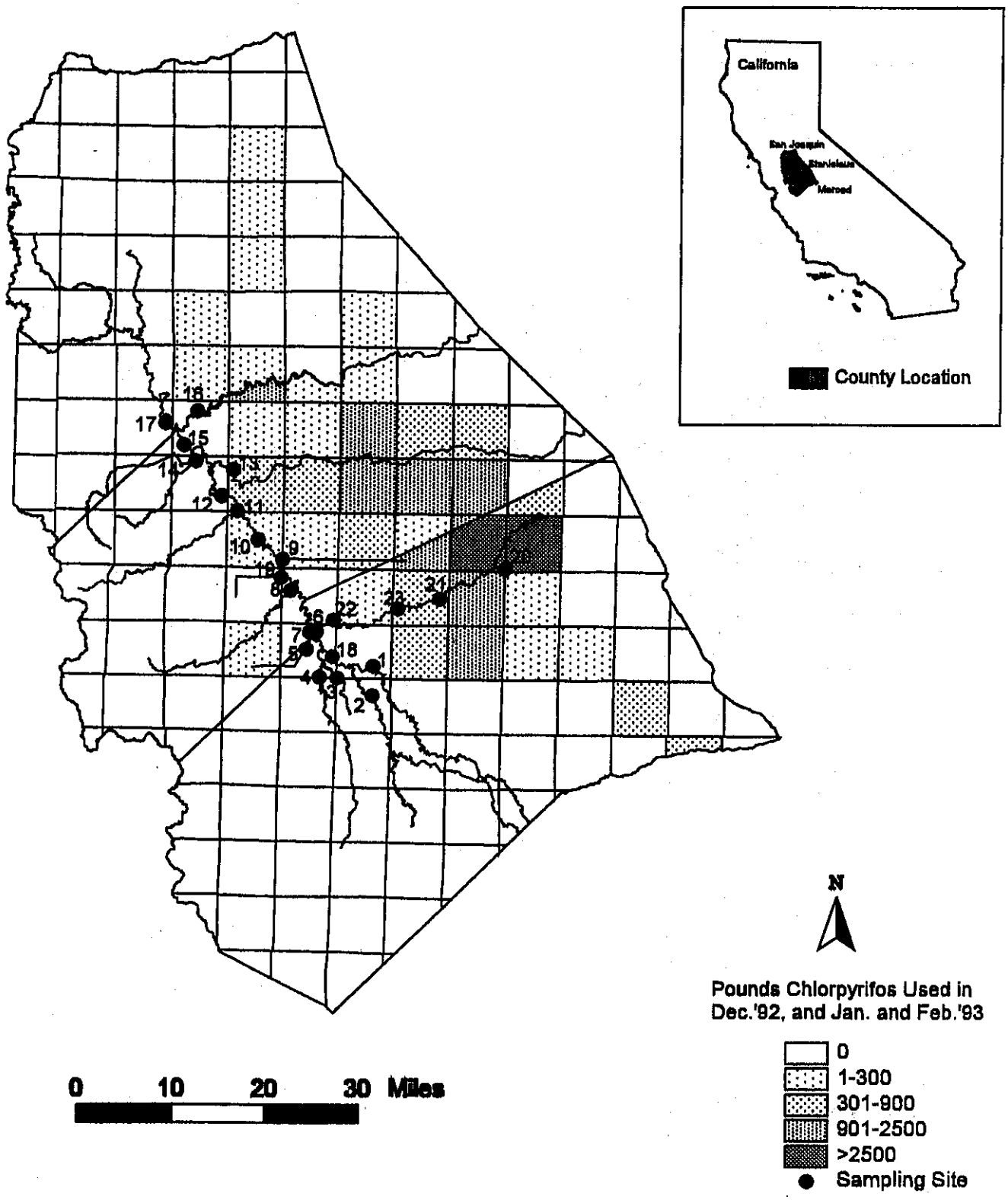


Figure 10. Chlorpyrifos use during the 1992-93 dormant spray season.

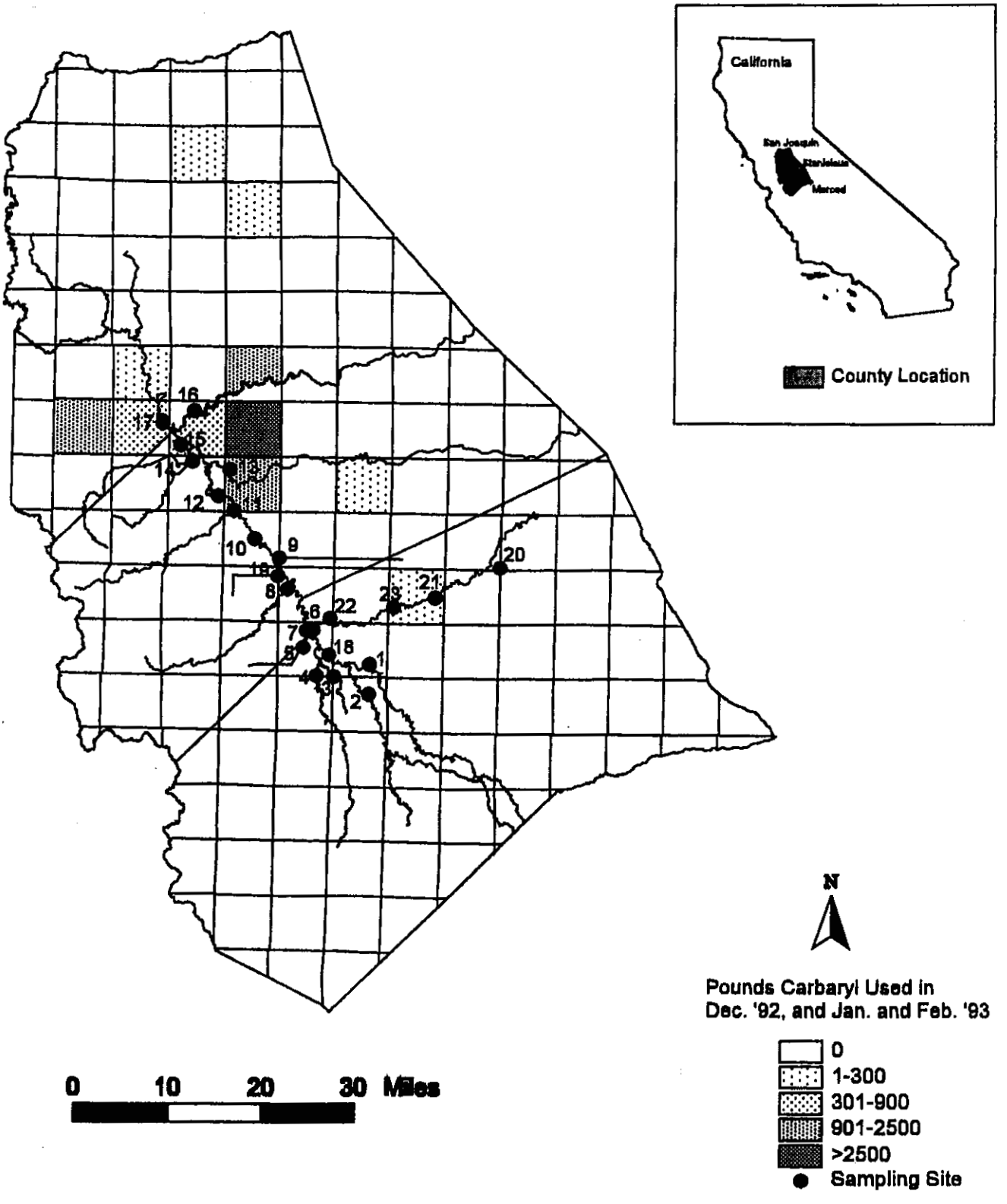


Figure 11. Carbaryl use during the 1992-93 dormant spray season.

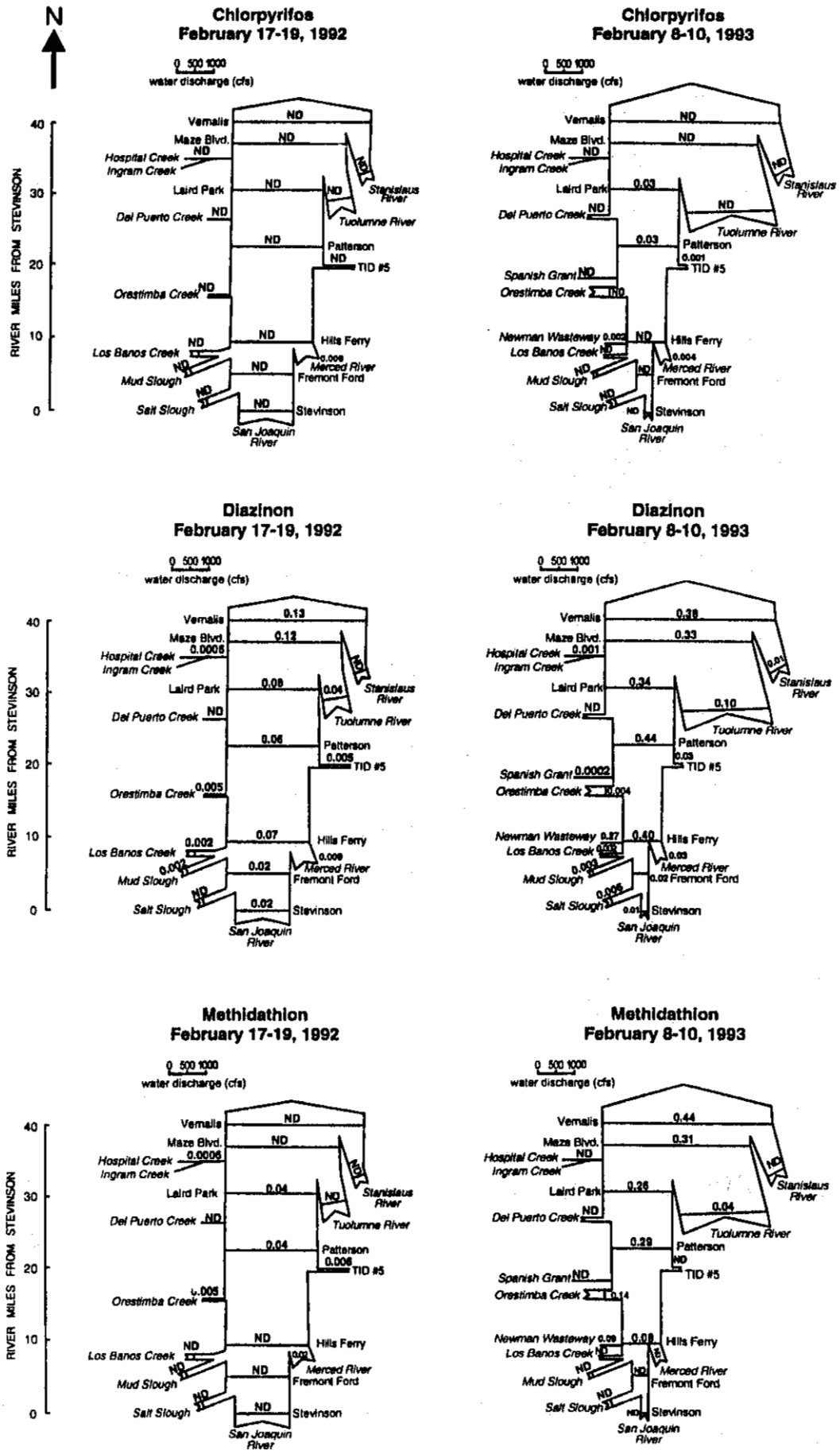


Figure 12. Pesticide loads (lbs/hour) in the San Joaquin River. Water flow is from south to north.

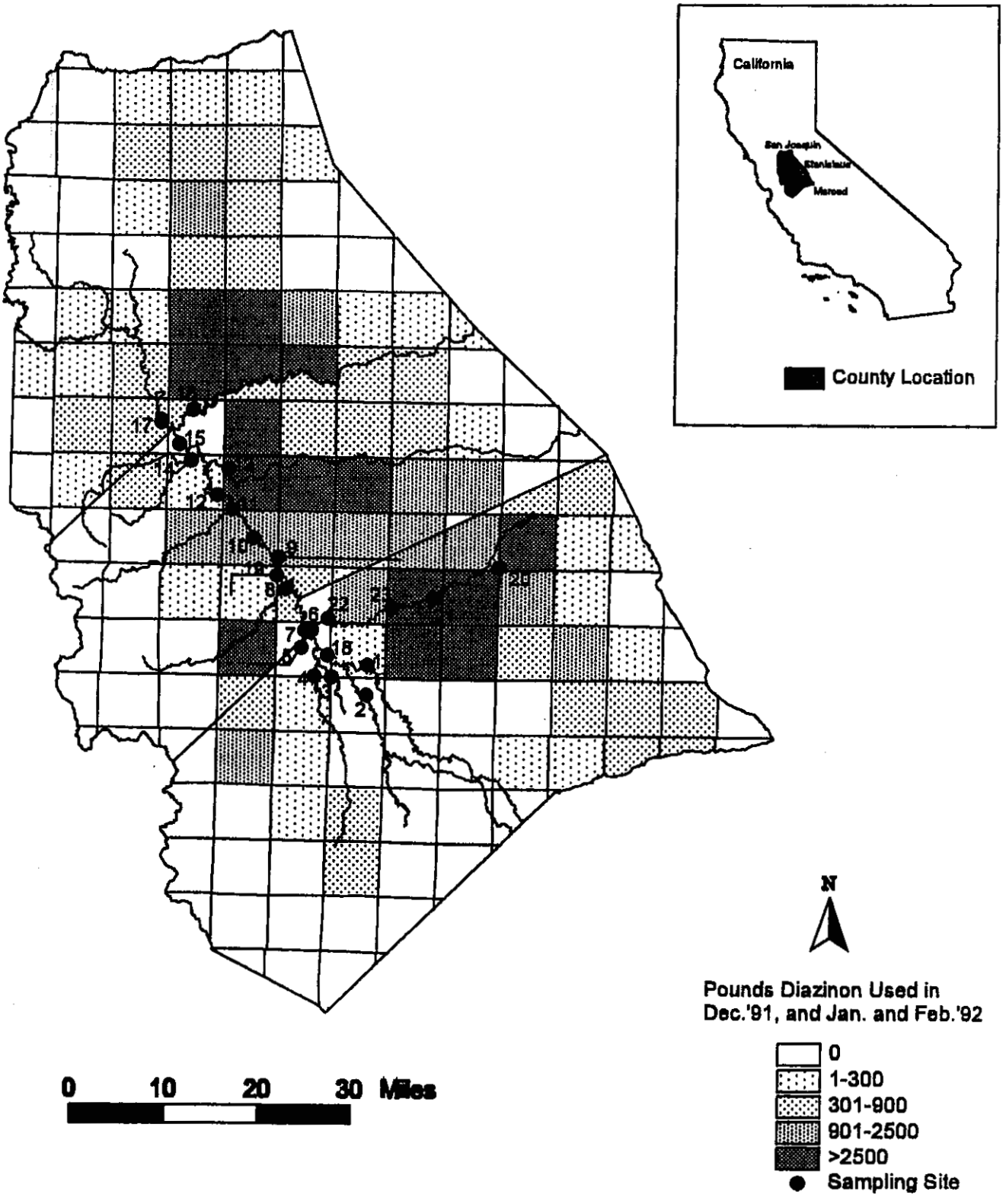


Figure 13. Diazinon use during the 1991-92 dormant spray season.

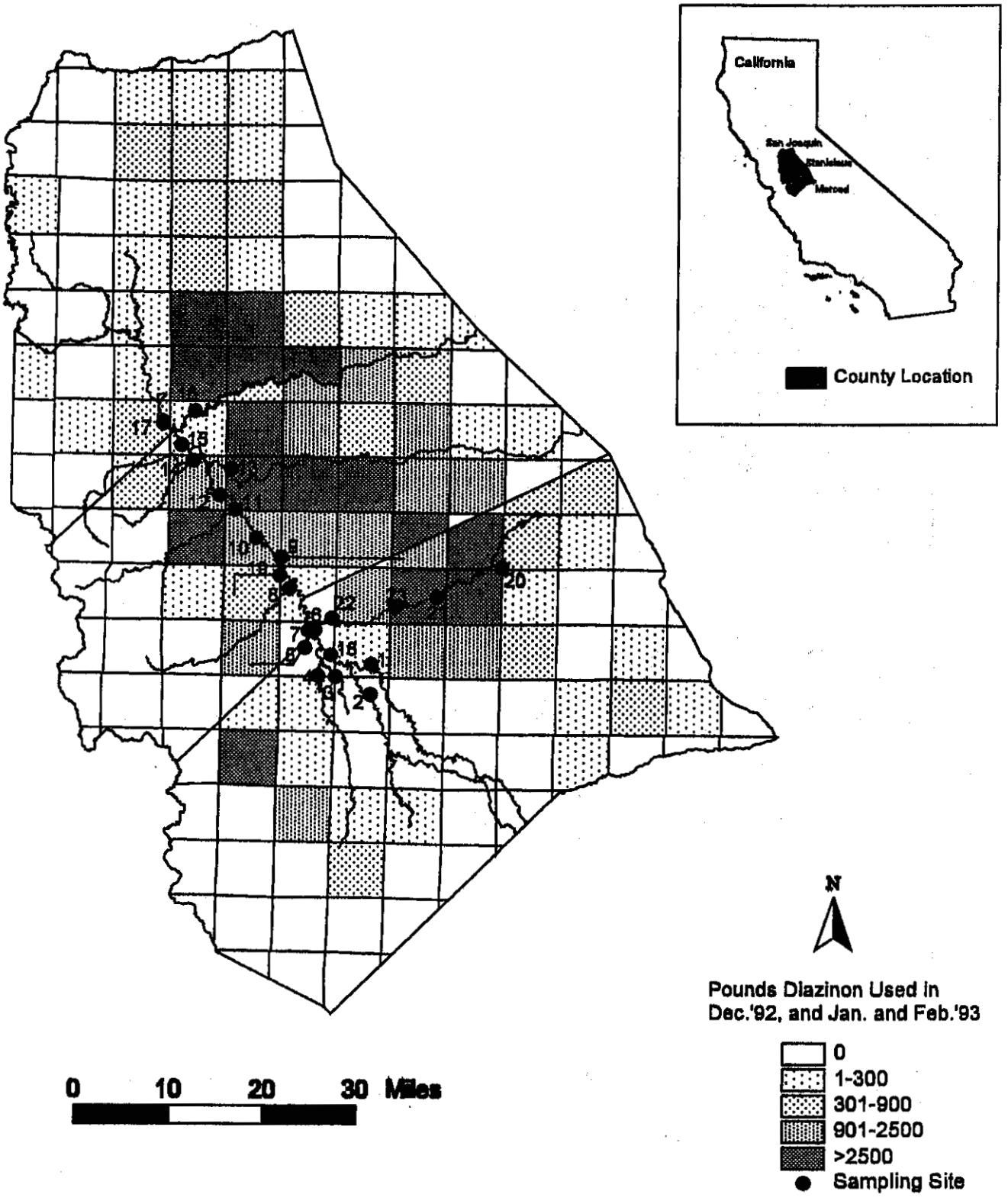


Figure 14. Diazinon use during the 1992-93 dormant spray season.

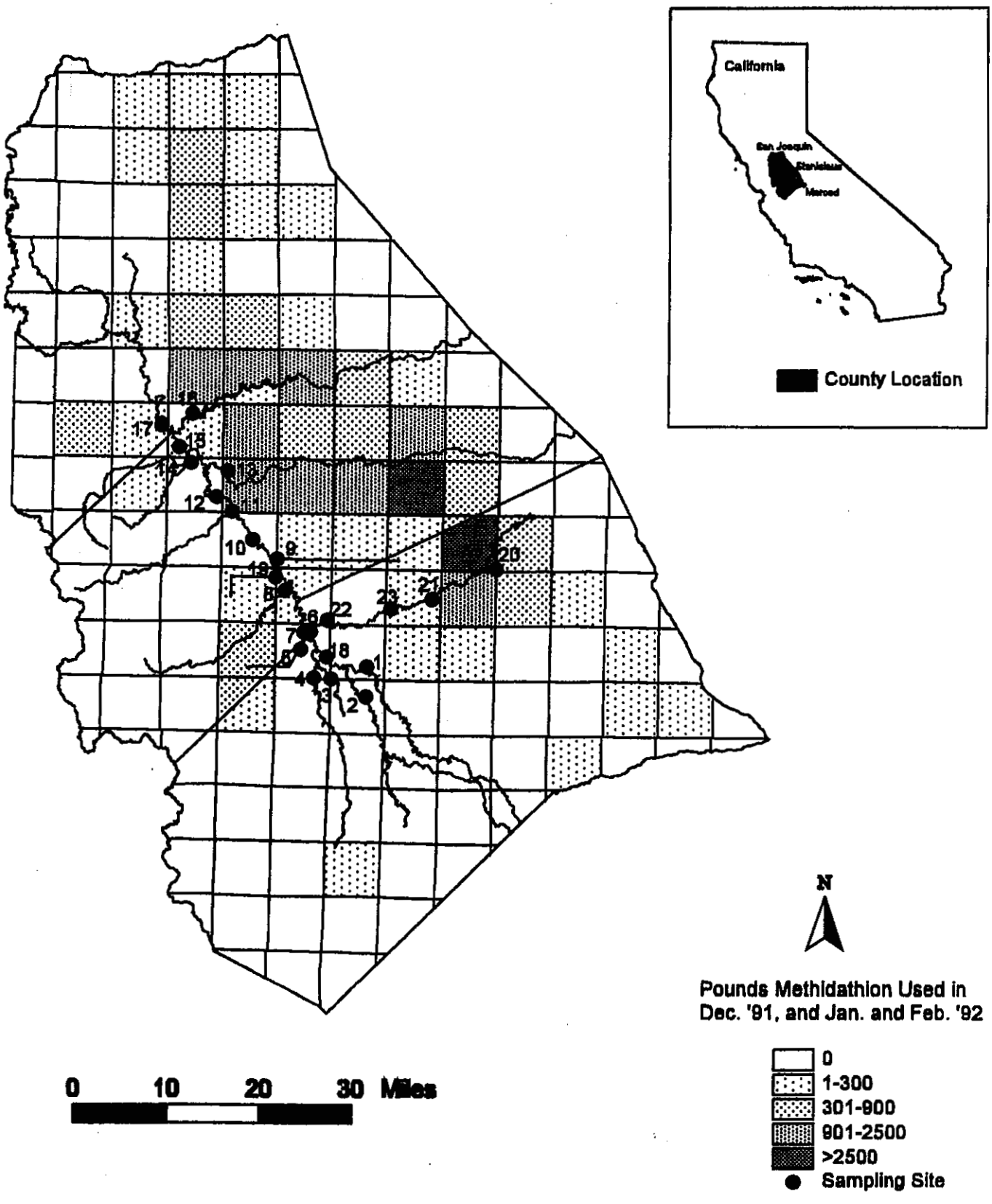


Figure 15. Methidathion use during the 1991-92 dormant spray season.

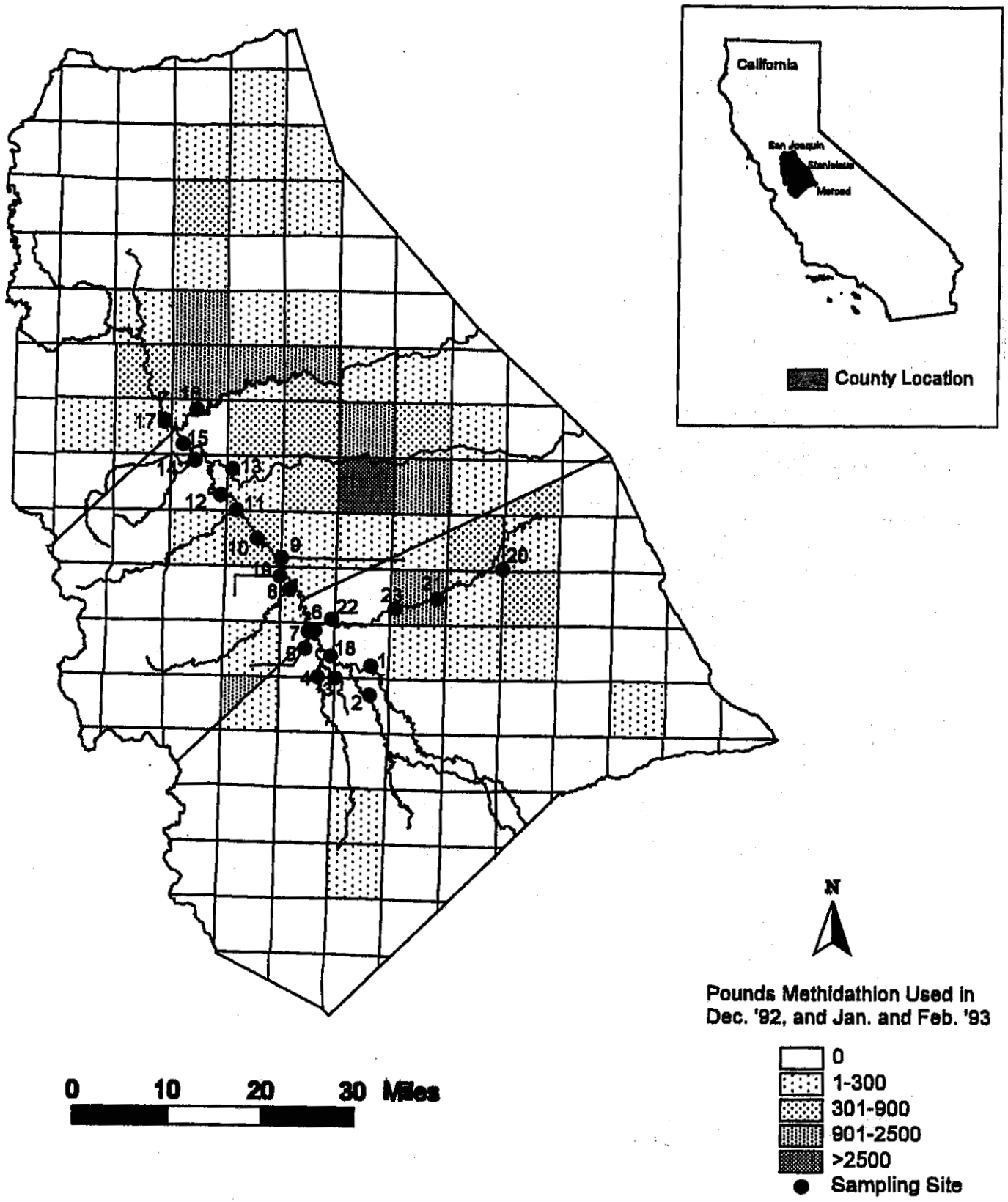
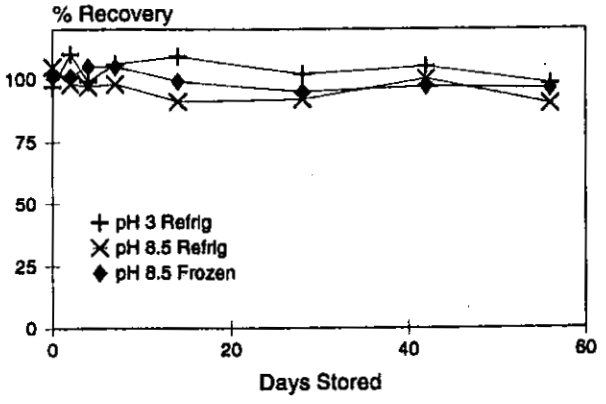


Figure 16. Methidathion use during the 1992-93 dormant spray season.

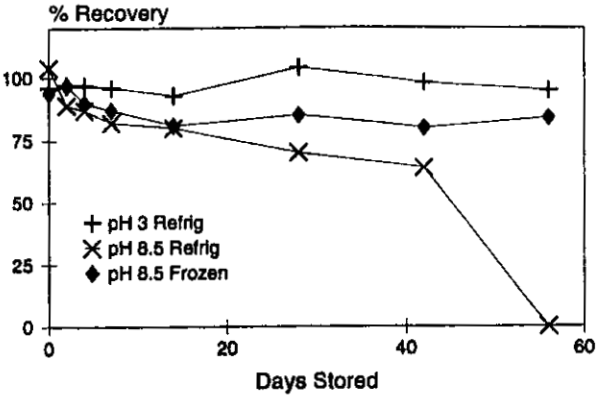
APPENDIX I. STORAGE STABILITY OF ORGANOPHOSPHATES AND CARBAMATES

Organophosphate storage stability under three conditions: 1. pH 3, refrigerated, glass bottles; 2. pH 8.5, refrigerated, glass bottles; 3. pH 8.5, frozen, polypropylene bottles.

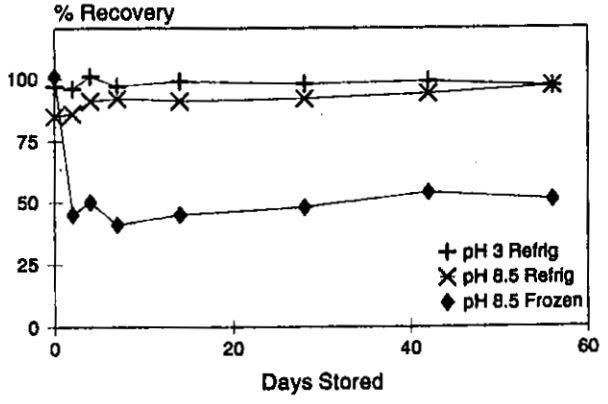
AZINPHOS-METHYL



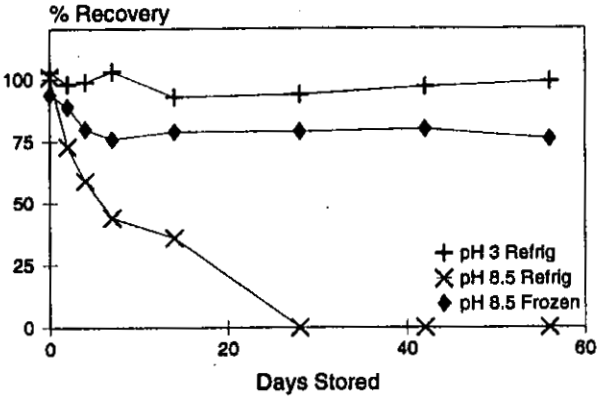
AZINPHOS-METHYL OA



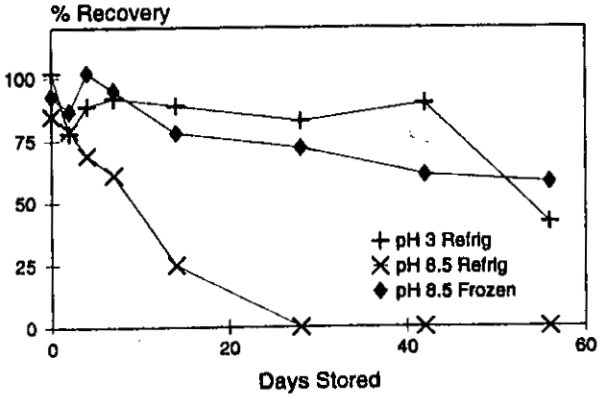
CHLORPYRIFOS



CHLORPYRIFOS OA

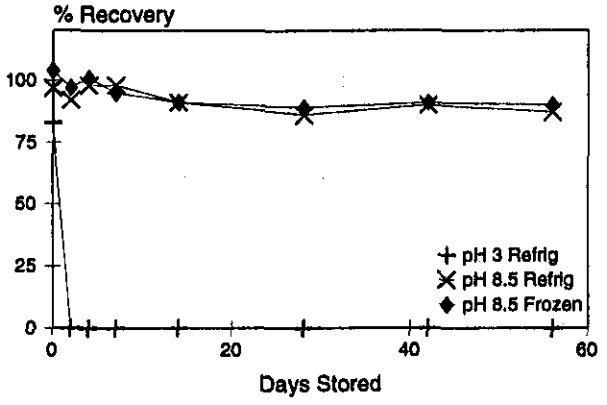


DDVP

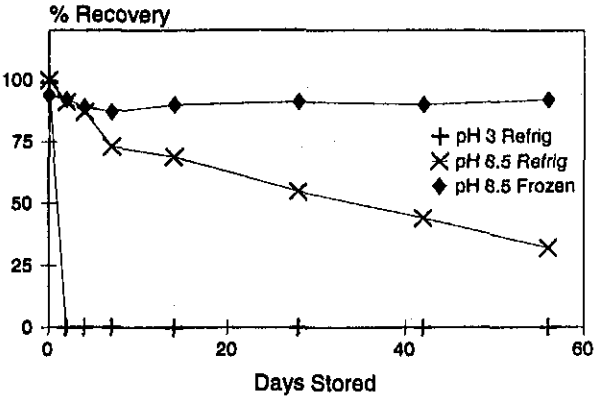


Organophosphate storage stability under three conditions: 1. pH 3, refrigerated, glass bottles; 2. pH 8.5, refrigerated, glass bottles; 3. pH 8.5, frozen, polypropylene bottles.

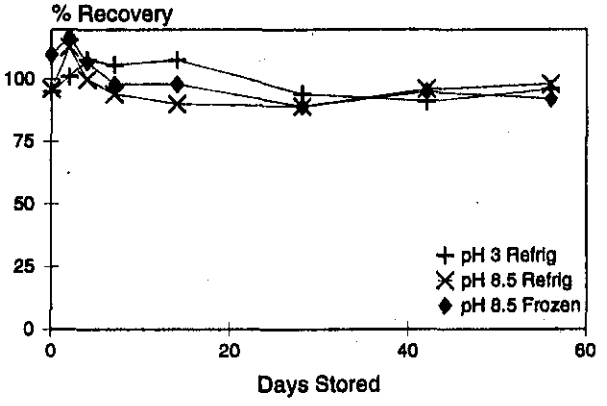
DIAZINON



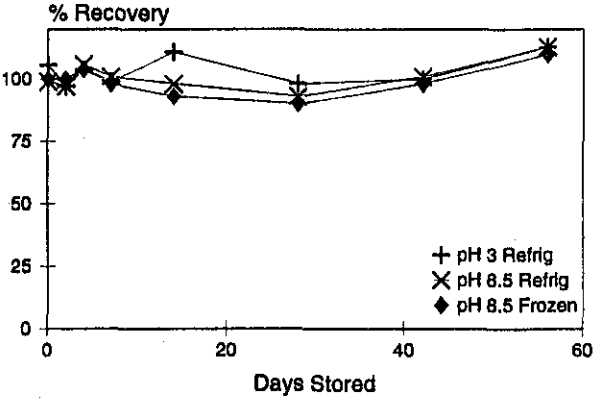
DIAZINON OA



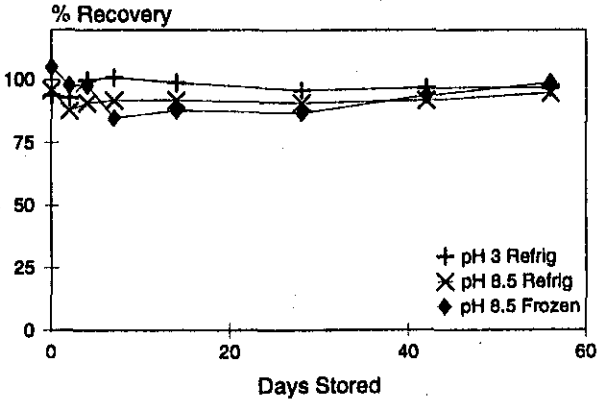
DIMETHOATE



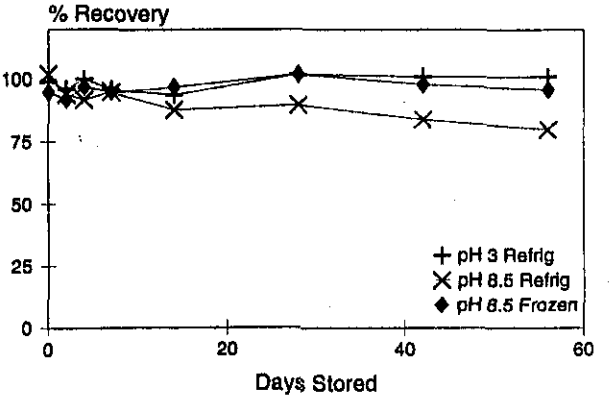
ETHOPROP



ETHYL PARATHION

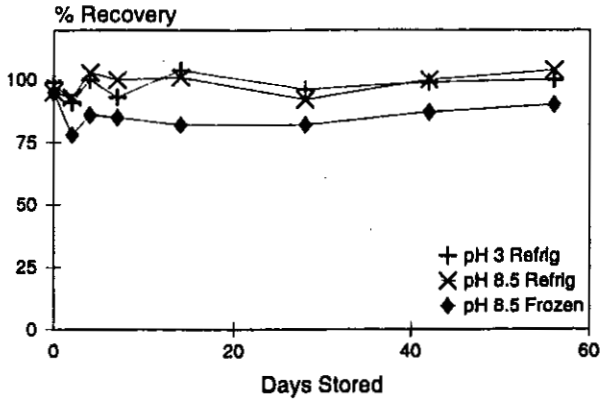


ETHYL PARATHION OA

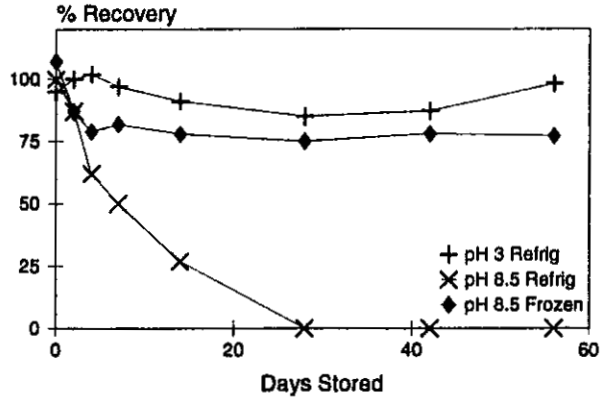


Organophosphate storage stability under three conditions: 1. pH 3, refrigerated, glass bottles; 2. pH 8.5, refrigerated, glass bottles; 3. pH 8.5, frozen, polypropylene bottles.

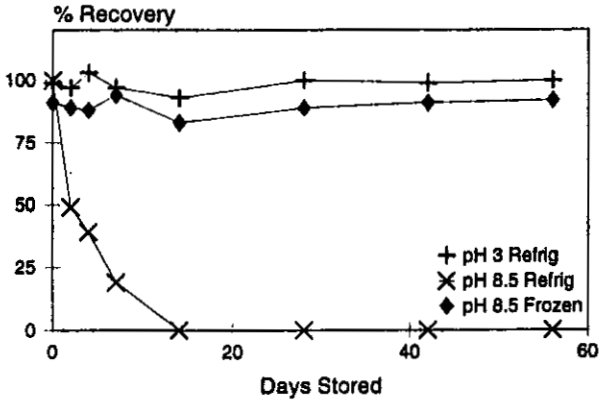
FONOFOS



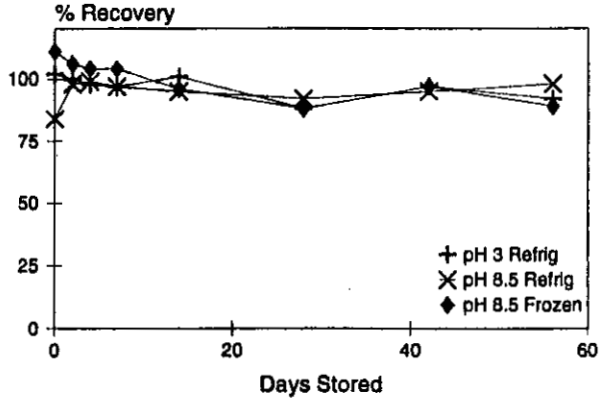
MALATHION



MALATHION OA



METHIDATHION



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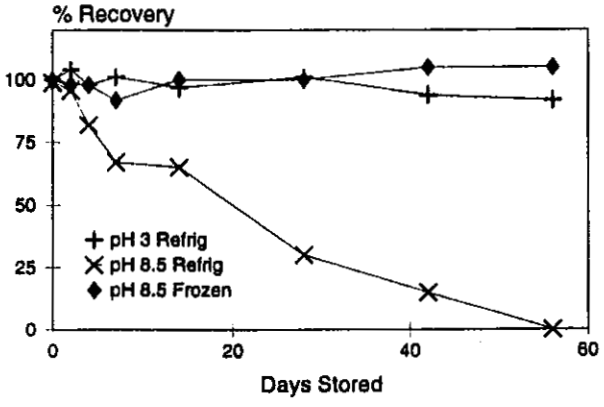
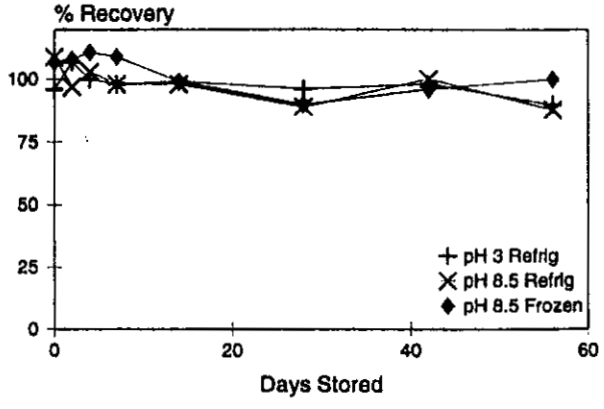
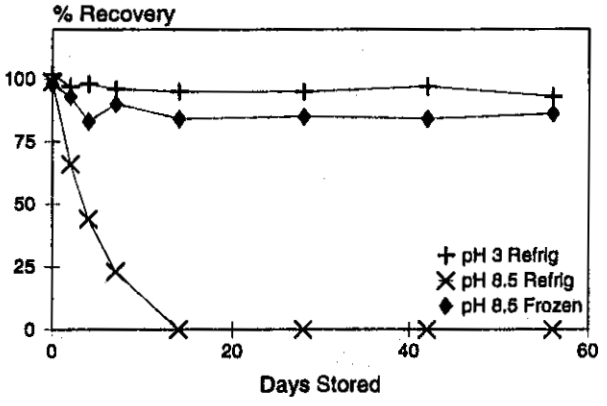


METHYL PARATHION

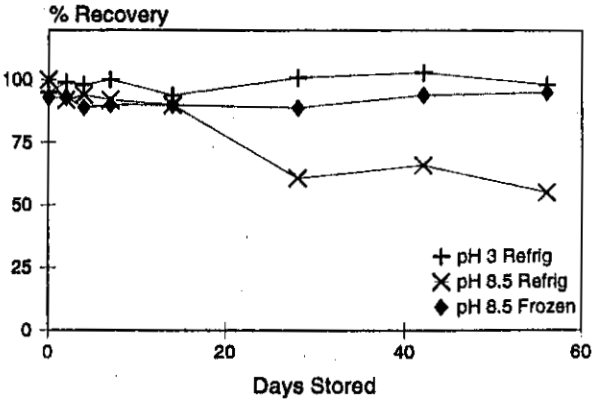


Organophosphate storage stability under three conditions: 1. pH 3, refrigerated, glass bottles; 2. pH 8.5, refrigerated, glass bottles; 3. pH 8.5, frozen, polypropylene bottles.

METHYL PARATHION OA



PHOSALONE



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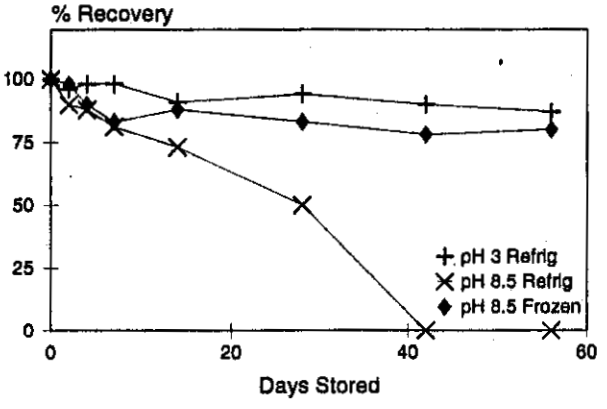
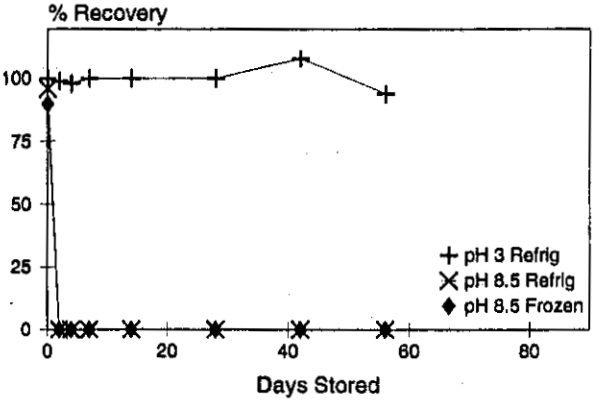
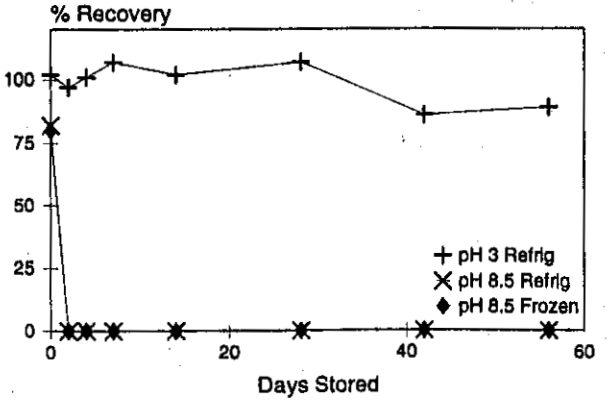


PHOSMET

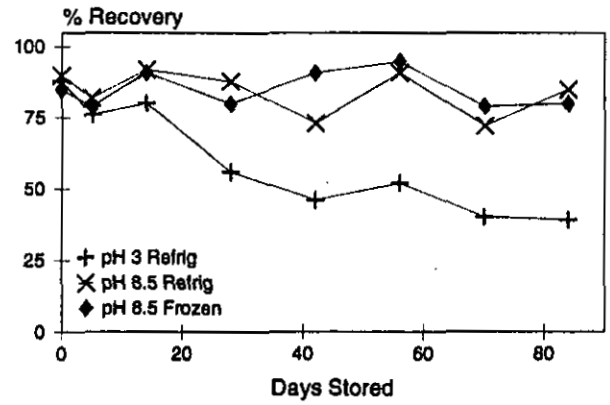


PHOSMET OA

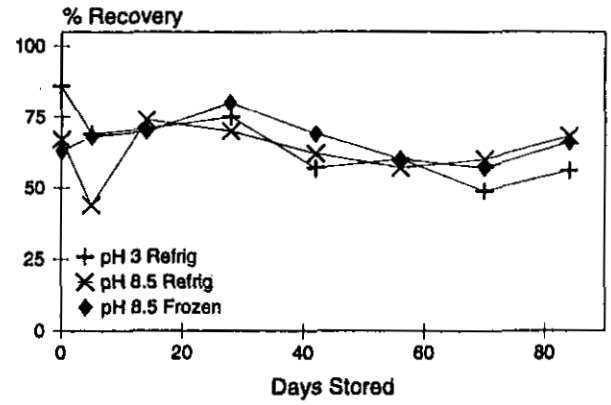


Carbamate storage stability under three conditions: 1. pH 3, refrigerated, glass bottles; 2. pH 8.5, refrigerated, glass bottles; 3. pH 8.5, frozen, polypropylene bottles.

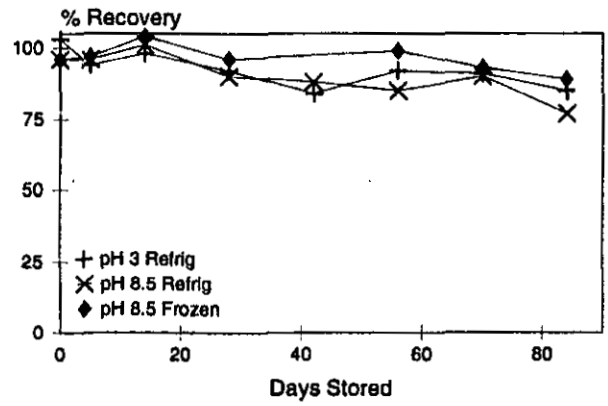
ALDICARB



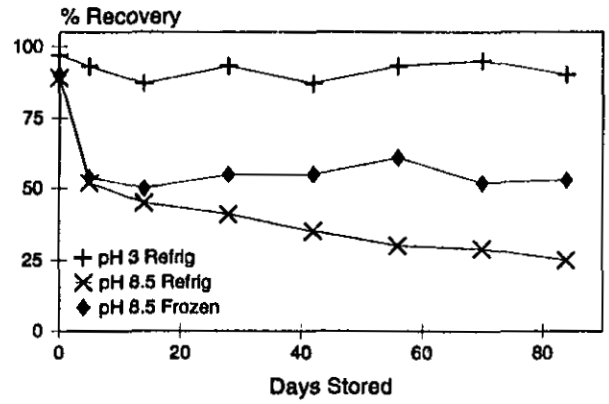
ALDICARB SULFOXIDE



ALDICARB SULFONE

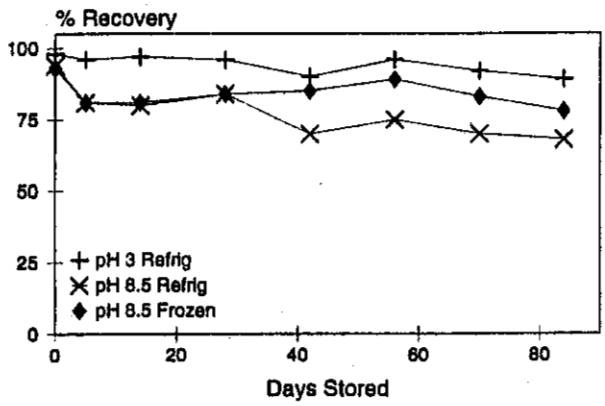


CARBARYL

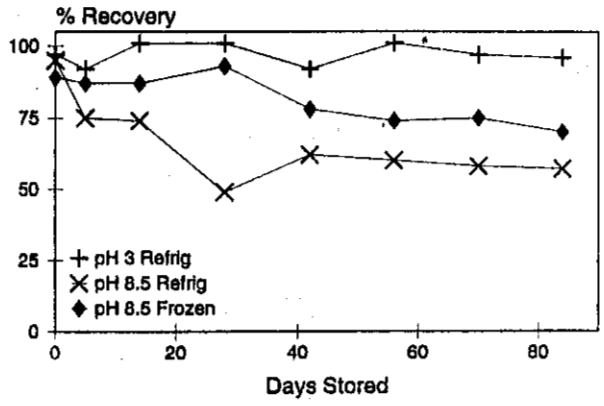


Carbamate storage stability under three conditions: 1. pH 3, refrigerated, glass bottles; 2. pH 8.5, refrigerated, glass bottles; 3. pH 8.5, frozen, polypropylene bottles.

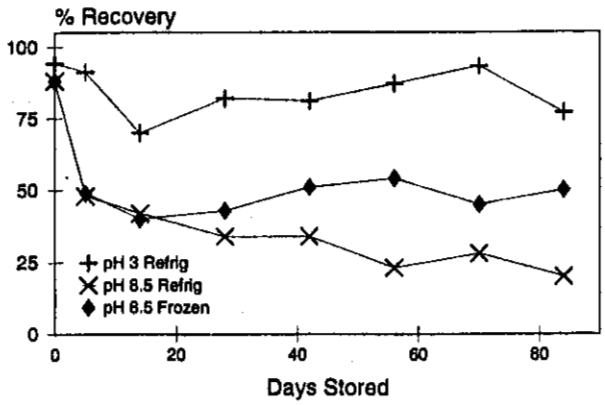
CARBOFURAN



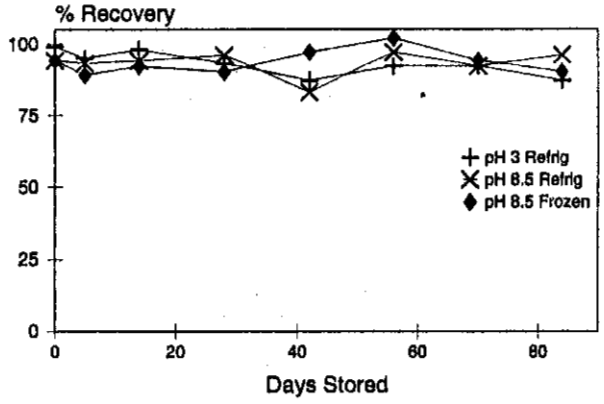
3-HYDROXY CARBOFURAN



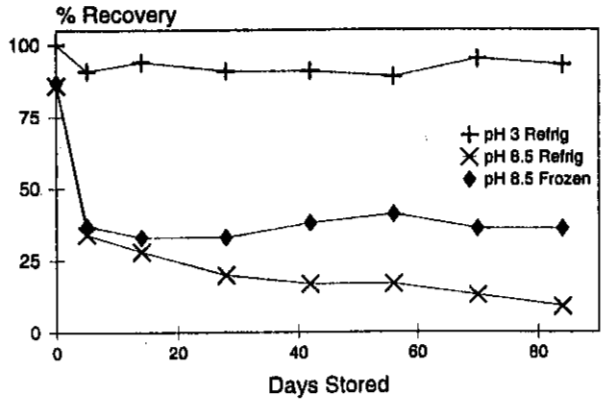
METHIOCARB



METHOMYL



OXAMYL



APPENDIX II. METHOD VALIDATION FOR ORGANOPHOSPHATE, CARBAMATE, AND ENDOSULFAN SCREENS

Appendix II. Method Validation

Table 1. Method validation data (% recoveries) for organophosphates in the surface water screen.

Study No.: 105 Sample Type: Surface Water
Study Name: San Joaquin River Chemist: Jean Hsu

Analyte	Spike Level (ppb)	Recovery (% of spike) Rep # 1	Rep # 2	Rep # 3	Mean	SD[1]	UCL[2]	UWL[3]	LWL[3]	LCL[2]
Azinphos-methyl	0.5	99	101	102	101	1.5				
	2.0	93	101	108	101	7.5				
	5.0	104	97	88	96	8.0				
Overall:					99	6.0	117	111	87	81
Azinphos-methyl OA	0.5	106	92	95	98	7.4				
	2.0	95	95	93	94	1.2				
	5.0	90	106	91	96	9.0				
Overall:					96	6.0	114	108	84	78
Chlorpyrifos	0.1	92	97	92	94	2.9				
	2.0	94	100	104	99	5.0				
	5.0	108	92	87	96	11.0				
Overall:					96	6.7	116	110	83	76
Chlorpyrifos OA	0.5	90	90	91	90	0.6				
	2.0	92	105	98	98	6.5				
	5.0	113	89	98	100	12.1				
Overall:					96	8.2	121	113	80	72
DDVP	0.1	95	97	103	98	4.2				
	2.0	90	113	108	104	12.1				
	5.0	97	95	87	93	5.3				
Overall:					98	8.3	123	115	82	73
Diazinon	0.1	94	104	102	100	5.3				
	2.0	86	79	105	90	13.5				
	5.0	100	98	90	96	5.3				
Overall:					95	8.8	122	113	78	69
Diazinon OA	0.5	90	96	88	91	4.2				
	2.0	92	101	106	100	7.1				
	5.0	104	107	93	101	7.4				
Overall:					97	7.2	119	112	83	76
Dimethoate	0.1	101	97	104	101	3.5				
	2.0	98	91	105	98	7.0				
	5.0	104	94	88	95	8.1				
Overall:					98	6.1	116	110	86	80
Ethoprop	0.1	93	98	96	96	2.5				
	1.0	98	99	99	99	0.6				
	5.0	95	96	92	94	2.1				
Overall:					96	2.2	105	103	93	91
Ethyl Parathion	0.1	97	98	95	97	1.5				
	2.0	91	96	97	95	3.2				
	5.0	105	96	95	99	5.5				
Overall:					97	3.7	108	104	89	86

Appendix II. Method Validation

Table 1. Method validation data (% recoveries) for organophosphates in the surface water screen.

Study No.: 105 Sample Type: Surface Water
Study Name: San Joaquin River Chemist: Jean Hsu

Analyte	Spike Level (ppb)	Recovery (% of spike) Rep # 1	Rep # 2	Rep # 3	Mean	SD[1]	UCL[2]	UWL[3]	LWL[3]	LCL[2]
Ethyl Parathion OA	0.5	84	95	93	91	5.9				
	2.0	92	98	101	97	4.6				
	5.0	105	94	94	98	6.4				
Overall:					95	5.9	113	107	83	77
Fonofos	0.1	93	98	96	96	2.5				
	1.0	96	97	98	97	1.0				
	5.0	92	94	94	93	1.2				
Overall:					95	1.9	102	100	94	92
Malathion	0.1	93	98	93	95	2.9				
	2.0	97	93	108	99	7.8				
	5.0	100	104	93	99	5.6				
Overall:					98	5.5	114	109	87	81
Malathion OA	0.5	100	106	94	100	6.0				
	2.0	90	97	107	98	8.5				
	5.0	112	108	105	108	3.5				
Overall:					102	7.3	124	117	88	80
Methidathion	0.1	89	91	102	94	7.0				
	2.0	96	108	110	105	7.6				
	5.0	104	107	91	101	8.5				
Overall:					100	8.2	124	116	83	75
Methidathion OA	0.5	95	100	86	94	7.1				
	2.0	102	103	100	102	1.5				
	5.0	106	90	97	98	8.0				
Overall:					98	6.4	117	111	85	78
Methyl Parathion	0.1	99	91	96	95	4.0				
	2.0	95	96	110	100	8.4				
	5.0	104	99	90	98	7.1				
Overall:					98	6.2	116	110	85	79
Methyl Parathion OA	0.5	85	87	88	87	1.5				
	2.0	93	105	102	100	6.2				
	5.0	105	91	102	99	7.4				
Overall:					95	8.1	120	112	79	71
Phorate	1.0	87	91	99	92	6.1	110	104	80	74
Phosalone	0.5	98	110	115	108	8.7				
	2.0	90	100	108	99	9.0				
	5.0	99	99	98	99	0.6				
Overall:					102	5.0	125	117	87	79
Phosalone OA	0.5	95	96	98	96	1.5				
	2.0	102	94	119	105	12.8				
	5.0	99	113	108	107	7.1				
Overall:					103	5.5	129	121	85	77

Appendix II. Method Validation

Table 1. Method validation data (% recoveries) for organophosphates in the surface water screen.

Study No.: 105 Sample Type: Surface Water

Study Name: San Joaquin River Chemist: Jean Hsu

Analyte	Spike Level (ppb)	Recovery (% of spike) Rep # 1	Rep # 2	Rep # 3	Mean	SD[1]	UCL[2]	UWL[3]	LWL[3]	LCL[2]
Phosmet	0.5	108	101	101	103	4.0				
	2.0	100	99	108	102	4.9				
	5.0	108	110	99	106	5.9				
Overall:					104	4.6	118	113	95	90
Phosmet OA	0.5	104	109	93	102	8.2				
	2.0	82	99	91	91	8.5				
	5.0	91	108	95	98	8.9				
Overall:					97	8.9	124	115	79	70

1. SD = standard deviation.

2. UCL = upper control limit. LCL = lower control limit. Upper and lower control limits = mean +\- 3SD

3. UWL = upper warning limit. LWL = lower warning limit. Upper and lower warning limits = mean +\- 2SD

Note: Tabled values have been rounded to the nearest unit. However, calculations were made from the raw data prior to rounding. Therefore, calculating from rounded numbers in the table will not exactly yield the tabled value. Differences should not be more than one unit.

Appendix II. Method Validation

Table 2. Method validation data (% recoveries) for carbamates in surface water screen.

Study No.: 105 Sample Type: Surface Water
Study Name: San Joaquin River Chemist: Jane White

Analyte	Spike Level (ppb)	Recovery (% of spike) Rep # 1	Rep # 2	Rep # 3	Rep # 4	Rep # 5	Mean	SD[1]	UCL[2]	UWL[3]	LWL[3]	LCL[2]
Aldicarb	0.5	100	84	104	84	96	93.6	9.21				
	1.0	94	93	85	106	80	91.6	9.91				
	5.0	82	93	95	81	102	90.6	8.96				
	10.0	98	98	97	84	96	94.6	5.98				
Overall:							92.6	8.10	117	109	76	68
Aldicarb	0.5	74	64	72	70	76	71.2	4.60				
Sulfoxide	1.0	75	65	63	62	74	67.8	6.22				
	5.0	70	52	71	70	59	64.4	8.50				
	10.0	72	71	74	73	70	72.0	1.58				
Overall:							68.9	6.16	87	81	57	50
Aldicarb	0.5	104	104	108	106	108	106.0	2.00				
Sulfone	1.0	98	96	94	84	100	94.4	6.23				
	5.0	100	100	96	98	92	97.2	3.35				
	10.0	100	97	103	100	99	99.8	2.17				
Overall:							99.4	5.63	116	111	88	82
Carbaryl	0.5	100	100	102	100	96	99.6	2.19				
	1.0	100	99	96	85	100	96.0	6.36				
	5.0	87	94	92	101	92	93.2	5.07				
	10.0	106	101	118	117	107	109.8	7.40				
Overall:							99.7	8.25	124	116	83	75
Carbofuran	0.5	92	100	104	100	94	98.0	4.90				
	1.0	102	106	101	87	102	99.6	7.30				
	5.0	97	97	96	98	92	96.0	2.35				
	10.0	101	98	106	103	98	101.2	3.42				
Overall:							98.7	4.88	113	108	89	84
Carbofuran	0.5	102	108	106	98	90	100.8	7.16				
3-Hydroxy	1.0	108	114	95	109	106	106.4	7.02				
	5.0	104	107	82	99	99	98.2	9.68				
	10.0	96	98	95	81	94	92.8	6.76				
Overall:							99.6	8.70	126	117	82	73
Methiocarb	0.5	104	108	106	92	108	103.6	6.69				
	1.0	99	96	96	80	97	93.6	7.70				
	5.0	97	95	93	101	89	95.0	4.47				
	10.0	103	94	111	98	97	100.6	6.66				
Overall:							98.2	7.27	120	113	84	76
Methomyl	0.5	98	96	108	82	74	91.6	13.52				
	1.0	105	107	97		94	100.8	6.24				
	5.0	99	103	99	94	108	100.6	5.22				
	10.0	93	99	96	84	99	94.2	6.22				
Overall:							96.6	8.87	123	114	79	70

Appendix II. Method Validation

Table 2. Method validation data (% recoveries) for carbamates in surface water screen.

Study No.: 105 Sample Type: Surface Water
Study Name: San Joaquin River Chemist: Jane White

Analyte	Spike Level (ppb)	Recovery (% of spike) Rep # 1	Rep # 2	Rep # 3	Rep # 4	Rep # 5	Mean	SD[1]	UCL[2]	UWL[3]	LWL[3]	LCL[2]
Oxamyl	0.5	112	106	106	100	96	104.0	6.16				
	1.0	99	101	92		110	100.5	7.42				
	5.0	102	112	75	97	96	96.4	13.54				
	10.0	100	95	90	72	101	91.6	11.80				
Overall:							98.0	10.62	130	119	77	66

1. SD = standard deviation.
2. UCL = upper control limit. LCL = lower control limit. Upper and lower control limits = mean +\- 3SD
3. UWL = upper warning limit. LWL = lower warning limit. Upper and lower warning limits = mean +\- 2SD

Appendix II. Method Validation

Table 3. Method validation data (% recoveries) for diazinon, diazinon OA, and endosulfans in surface water screen.

Screen: Endosulfan
Study No.: 105 Sample Type: Surface Water
Study Name: San Joaquin River Chemist: K. Hefner

Analyte	Spike Level (ppb)	Recovery (% of spike) Rep # 1	Rep # 2	Rep # 3	Rep # 4	Rep # 5	Mean	SD[1]	UCL[2]	UWL[3]	LWL[3]	LCL[2]
Diazinon	0.5	102	96	96	96		97.5	3.00				
	2.0	93	88				90.5	3.54				
Overall:							95.2	4.58	109	104	86	81
Diazinon	0.5	112	98	104	104		104.5	5.74				
OA	2.0	107	98				102.5	6.36				
Overall:							103.8	5.38	120	115	93	88
Endosulfan I	0.01	94	104	83	80	86	89.4	9.69				
	1.0	99	95				97.0	2.83				
	5.0	89	88	91			89.3	1.53				
Overall:							90.9	7.31	113	106	76	69
Endosulfan II	0.01	118	120	82	100	118	107.6	16.46				
	1.0	99	116				107.5	12.02				
	5.0	90	91	93			91.3	1.53				
Overall:							102.7	14.09	145	131	75	60
Endosulfan	0.5	120	94	82	110	70	95.2	20.28				
sulfate	1.0	97	114				105.5	12.02				
	5.0	91	113	104			102.7	11.06				
Overall:							99.5	15.74	147	131	68	52

1. SD = standard deviation.
2. UCL = upper control limit. LCL = lower control limit. Upper and lower control limits = mean +\- 3SD
3. UWL = upper warning limit. LWL = lower warning limit. Upper and lower warning limits = mean +\- 2SD

APPENDIX III. CONTINUING QUALITY CONTROL

Appendix III. Continuing QC. Organophosphate Screen - Winter 1991-92

Table 1. Continuing quality control data for the Winter 1991-92 San Joaquin River study.

Screen: Organophosphate	UCL = 117	Sample Type: Surface Water
Analyte: Azinphos-methyl	UWL = 111	Lab: CDFA
MDL: 0.05 ppb	LWL = 87	Chemist: Jean Hsu
	LCL = 81	

Sample Analyzed with Each Extraction Set (Sample Number)	Spike Level (ppb)	Results (ppb)	Recovery (%)
752, 848	0.5	0.59	118**
926, 1243	0.5	0.52	104
591, 902	0.5	0.56	112
824	0.5	0.54	108
798	0.5	0.55	110
971, 1051, 1057, 1075, 1087, 1123, 1135, 1141, 1269, 1275	1.0	1.01	101
1069	0.5	0.57	114
1347	0.5	0.55	110
866	0.5	0.53	106
939, 946, 977, 1001, 1013, 1031, 1037	0.5	0.50	100
872, 892, 965, 983, 989, 1019, 1025, 1147, 1153, 1311, 1377, 1378, 1380	0.5	0.49	98
1105	0.5	0.51	102
1093, 1007, 995, 1381, 1335	0.5	0.54	108

UCL = upper control limit, UWL = upper warning limit, LWL = lower warning limit, LCL = lower control limit.
** Matrix spike recovery fell above the upper control limit.

Table 2. Continuing quality control data (% recoveries) for the Winter 1991-92 San Joaquin River study.

Screen: Organophosphate	UCL = 114	Sample Type: Surface Water
Analyte: Azinophos-Methyl OA	UWL = 108	Lab: CDFA
MDL: 0.30 ppb	LWL = 84	Chemist: Jean Hsu
	LCL = 78	

Sample Analyzed with Each Extraction Set (Sample Number)	Spike Level (ppb)	Results (ppb)	Recovery (%)
776, 812	0.5	0.57	114
884, 1379	0.5	0.44	88
953, 960, 1043, 1081, 1099, 1111, 1117, 1365, 1371	0.5	0.59	118**

UCL = upper control limit, UWL = upper warning limit, LWL = lower warning limit, LCL = lower control limit.
** Matrix spike recovery fell above the upper control limit.

Table 3. Continuing quality control data (% recoveries) for the Winter 1991-92 San Joaquin River study.

Screen: Organophosphate	UCL = 116	Sample Type: Surface Water
Analyte: Chlorpyrifos	UWL = 110	Lab: CDFA
MDL: 0.05 ppb	LWL = 83	Chemist: Jean Hsu
	LCL = 76	

Sample Analyzed with Each Extraction Set (Sample Number)	Spike Level (ppb)	Results (ppb)	Recovery (%)
752, 848	0.5	0.52	104
926, 1243	0.5	0.43	86
591, 902	0.5	0.46	92
824	0.5	0.54	108
798	0.5	0.56	112
971, 1051, 1057, 1075, 1087, 1123, 1135, 1141, 1269, 1275	1.0	0.90	90
1069	0.5	0.51	102
1347	0.5	0.52	104
866	0.5	0.56	112
939, 946, 977, 1001, 1013, 1031, 1037	0.5	0.57	114
872, 892, 965, 983, 989, 1019, 1025, 1147, 1153, 1311, 1377, 1378, 1380	0.5	0.57	114
1105	0.5	0.59	118**
1093, 1007, 995, 1381, 1335	0.5	0.57	114

UCL = upper control limit, UWL = upper warning limit, LWL = lower warning limit, LCL = lower control limit.
** Matrix spike recovery fell above the upper control limit.

Appendix III. Continuing QC. Organophosphate Screen - Winter 1991-92

Table 4. Continuing quality control data (% recoveries) for the Winter 1991-92 San Joaquin River study.

Screen: Organophosphate | UCL = 121 | Sample Type: Surface Water
Analyte: Chlorpyrifos OA | UWL = 113 | Lab: CDFA
MDL: 0.05 ppb | LWL = 80 | Chemist: Jean Hsu
LCL = 72

Sample Analyzed with Each Extraction Set (Sample Number)	Spike Level (ppb)	Results (ppb)	Recovery (%)
758, 896	0.5	0.45	90
776, 812	0.5	0.60	120
884, 1379	0.5	0.56	112
1251	0.5	0.54	108
953, 960, 1043, 1081, 1099, 1111, 1117, 1365, 1371	0.5	0.41	82
1069	0.5	0.55	110

UCL = upper control limit, UWL = upper warning limit, LWL = lower warning limit, LCL = lower control limit.

Table 5. Continuing quality control data (% recoveries) for the Winter 1991-92 San Joaquin River study.

Screen: Organophosphate | UCL = 123 | Sample Type: Surface Water
Analyte: DDVP | UWL = 115 | Lab: CDFA
MDL: 0.05 ppb | LWL = 82 | Chemist: Jean Hsu
LCL = 73

Sample Analyzed with Each Extraction Set (Sample Number)	Spike Level (ppb)	Results (ppb)	Recovery (%)
752, 848	0.5	0.54	108
926, 1243	0.5	0.44	88
591, 902	0.5	0.44	88
824	0.5	0.59	118
798	0.5	0.53	106
971, 1051, 1057, 1075, 1087, 1123, 1135, 1141, 1269, 1275	1.0	0.80	80
1069	0.5	0.43	86
1347	0.5	0.47	94
866	0.5	0.43	86
939, 946, 977, 1001, 1013, 1031, 1037	0.5	0.52	104
872, 892, 965, 983, 989, 1019, 1025, 1147, 1153, 1311, 1377, 1378, 1380	0.5	0.46	92
1105	0.5	0.51	102
1093, 1007, 995, 1381, 1335	0.5	0.50	100

UCL = upper control limit, UWL = upper warning limit, LWL = lower warning limit, LCL = lower control limit.

Table 6. Continuing quality control data (% recoveries) for the Winter 1991-92 San Joaquin River study.

Screen: Organophosphate | UCL = 122 | Sample Type: Surface Water
Analyte: Diazinon | UWL = 113 | Lab: CDFA
MDL: 0.05 ppb | LWL = 78 | Chemist: Jean Hsu
LCL = 69

Sample Analyzed with Each Extraction Set (Sample Number)	Spike Level (ppb)	Results (ppb)	Recovery (%)
798	0.5	0.49	98
971, 1051, 1057, 1075, 1087, 1123, 1135, 1141, 1269, 1275	1.0	0.89	89
1069	0.5	0.49	98
1347	0.5	0.48	96
866	0.5	0.50	100
939, 946, 977, 1001, 1013, 1031, 1037	0.5	0.53	106
872, 892, 965, 983, 989, 1019, 1025, 1147, 1153, 1311, 1377, 1378, 1380	0.5	0.45	90
1105	0.5	0.51	102
1093, 1007, 995, 1381, 1335	0.5	0.51	102

UCL = upper control limit, UWL = upper warning limit, LWL = lower warning limit, LCL = lower control limit.

Table 7. Continuing quality control data (% recoveries) for the Winter 1991-92 San Joaquin River study.

Screen: Organophosphate	UCL = 119	Sample Type: Surface Water
Analyte: Diazinon OA	UWL = 112	Lab: CDFA
MDL: 0.05 ppb	LWL = 83	Chemist: Jean Hsu
	LCL = 76	

Sample Analyzed with Each Extraction Set (Sample Number)	Spike Level (ppb)	Results (ppb)	Recovery (%)
758, 896	0.5	0.52	104
953, 960, 1043, 1081, 1099, 1111, 1117, 1365, 1371	0.5	0.53	106
971, 1051, 1057, 1075, 1087, 1123, 1135, 1141, 1269, 1275	0.5	0.45	90
1310	0.5	0.49	98

UCL = upper control limit, UWL = upper warning limit, LWL = lower warning limit, LCL = lower control limit.

Table 8. Continuing quality control data (% recoveries) for the Winter 1991-92 San Joaquin River study.

Screen: Organophosphate	UCL = 116	Sample Type: Surface Water
Analyte: Dimethoate	UWL = 110	Lab: CDFA
MDL: 0.05 ppb	LWL = 86	Chemist: Jean Hsu
	LCL = 80	

Sample Analyzed with Each Extraction Set (Sample Number)	Spike Level (ppb)	Results (ppb)	Recovery (%)
752, 848	0.5	0.54	108
926, 1243	0.5	0.45	90
591, 902	0.5	0.51	102
824	0.5	0.52	104
798	0.5	0.53	106
971, 1051, 1057, 1075, 1087, 1123, 1135, 1141, 1269, 1275	1.0	0.92	92
1069	0.5	0.51	102
1347	0.5	0.49	98
866	0.5	0.55	110
939, 946, 977, 1001, 1013, 1031, 1037	0.5	0.51	102
872, 892, 965, 983, 989, 1019, 1025, 1147, 1153, 1311, 1377, 1378, 1380	0.5	0.52	104
1105	0.5	0.50	100
1093, 1007, 995, 1381, 1335	0.5	0.51	102

UCL = upper control limit, UWL = upper warning limit, LWL = lower warning limit, LCL = lower control limit.

Table 9. Continuing quality control data (% recoveries) for the Winter 1991-92 San Joaquin River study.

Screen: Organophosphate	UCL = 108	Sample Type: Surface Water
Analyte: Ethyl Parathion	UWL = 104	Lab: CDFA
MDL: 0.05 ppb	LWL = 89	Chemist: Jean Hsu
	LCL = 86	

Sample Analyzed with Each Extraction Set (Sample Number)	Spike Level (ppb)	Results (ppb)	Recovery (%)
926, 1243	0.5	0.49	98
758, 896	0.5	0.52	104
824	0.5	0.41	82*
953, 960, 1043, 1081, 1099, 1111, 1117, 1365, 1371	0.5	0.50	100
971, 1051, 1057, 1075, 1087, 1123, 1135, 1141, 1269, 1275	0.5	0.46	92
939, 946, 977, 1001, 1013, 1031, 1037	0.5	0.53	106

UCL = upper control limit, UWL = upper warning limit, LWL = lower warning limit, LCL = lower control limit.
* Matrix spike recovery fell below the lower control limit.

Table 10. Continuing quality control data (% recoveries) for the Winter 1991-92 San Joaquin River study.

Screen: Organophosphate
Analyte: Ethyl Parathion OA
MDL: 0.05 ppb

UCL = 113
UWL = 107
LWL = 83
LCL = 77

Sample Type: Surface Water
Lab: CDFA
Chemist: Jean Hsu

Sample Analyzed with Each Extraction Set (Sample Number)	Spike Level (ppb)	Results (ppb)	Recovery (%)
758, 896	0.5	0.47	94
776, 812	0.5	0.43	86
884, 1379	0.5	0.54	108
953, 960, 1043, 1081, 1099, 1111, 1117, 1365, 1371	0.5	0.58	116**
1069	0.5	0.50	100

UCL = upper control limit, UWL = upper warning limit, LWL = lower warning limit, LCL = lower control limit.
** Matrix spike recovery fell above the upper control limit.

Table 11. Continuing quality control data (% recoveries) for the Winter 1991-92 San Joaquin River study.

Screen: Organophosphate
Analyte: Malathion
MDL: 0.05 ppb

UCL = 114
UWL = 109
LWL = 87
LCL = 81

Sample Type: Surface Water
Lab: CDFA
Chemist: Jean Hsu

Sample Analyzed with Each Extraction Set (Sample Number)	Spike Level (ppb)	Results (ppb)	Recovery (%)
752, 848	0.5	0.54	108
926, 1243	0.5	0.42	84
591, 902	0.5	0.48	96
824	0.5	0.52	104
798	0.5	0.54	108
971, 1051, 1057, 1075, 1087, 1123, 1135, 1141, 1269, 1275	1.0	0.94	94
1069	0.5	0.53	106
1347	0.5	0.51	102
866	0.5	0.55	110
939, 946, 977, 1001, 1013, 1031, 1037	0.5	0.48	96
872, 892, 965, 983, 989, 1019, 1025, 1147, 1153, 1311, 1377, 1378, 1380	0.5	0.53	106
1105	0.5	0.54	108
1093, 1007, 995, 1381, 1335	0.5	0.53	106

UCL = upper control limit, UWL = upper warning limit, LWL = lower warning limit, LCL = lower control limit.

Table 12. Continuing quality control data (% recoveries) for the Winter 1991-92 San Joaquin River study.

Screen: Organophosphate
Analyte: Malathion OA
MDL: 0.05 ppb

UCL = 124
UWL = 117
LWL = 88
LCL = 80

Sample Type: Surface Water
Lab: CDFA
Chemist: Jean Hsu

Sample Analyzed with Each Extraction Set (Sample Number)	Spike Level (ppb)	Results (ppb)	Recovery (%)
758, 896	0.5	0.56	112
953, 960, 1043, 1081, 1099, 1111, 1117, 1365, 1371	0.5	0.52	104
971, 1051, 1057, 1075, 1087, 1123, 1135, 1141, 1269, 1275	0.5	0.57	114
1310	0.5	0.53	106

UCL = upper control limit, UWL = upper warning limit, LWL = lower warning limit, LCL = lower control limit.

Table 13. Continuing quality control data (% recoveries) for the Winter 1991-92 San Joaquin River study.

Screen: Organophosphate	UCL = 124	Sample Type: Surface Water
Analyte: Methidathion	UWL = 116	Lab: CDFA
MDL: 0.05 ppb	LWL = 83	Chemist: Jean Hsu
	LCL = 75	

Sample Analyzed with Each Extraction Set (Sample Number)	Spike Level (ppb)	Results (ppb)	Recovery (%)
752, 848	0.5	0.50	100
926, 1243	0.5	0.47	94
591, 902	0.5	0.49	98
824	0.5	0.57	114
798	0.5	0.54	108
971, 1051, 1057, 1075, 1087, 1123, 1135, 1141, 1269, 1275	1.0	0.97	97
1069	0.5	0.54	108
1347	0.5	0.51	102
866	0.5	0.56	112
939, 946, 977, 1001, 1013, 1031, 1037	0.5	0.55	110
872, 892, 965, 983, 989, 1019, 1025, 1147, 1153, 1311, 1377, 1378, 1380	0.5	0.58	116
1105	0.5	0.48	96
1093, 1007, 995, 1381, 1335	0.5	0.52	104

UCL = upper control limit, UWL = upper warning limit, LWL = lower warning limit, LCL = lower control limit.

Table 14. Continuing quality control data (% recoveries) for the Winter 1991-92 San Joaquin River study.

Screen: Organophosphate	UCL = 117	Sample Type: Surface Water
Analyte: Methidation OA	UWL = 111	Lab: CDFA
MDL: 0.05 ppb	LWL = 85	Chemist: Jean Hsu
	LCL = 78	

Sample Analyzed with Each Extraction Set (Sample Number)	Spike Level (ppb)	Results (ppb)	Recovery (%)
758, 896	0.5	0.50	100
776, 812	0.5	0.60	120**
884, 1379	0.5	0.56	112
953, 960, 1043, 1081, 1099, 1111, 1117, 1365, 1371	0.5	0.56	112
1069	0.5	0.52	104

UCL = upper control limit, UWL = upper warning limit, LWL = lower warning limit, LCL = lower control limit.
** Matrix spike recovery fell above the upper control limit.

Table 15. Continuing quality control data (% recoveries) for the Winter 1991-92 San Joaquin River study.

Screen: Organophosphate	UCL = 116	Sample Type: Surface Water
Analyte: Methyl Parathion	UWL = 110	Lab: CDFA
MDL: 0.05 ppb	LWL = 85	Chemist: Jean Hsu
	LCL = 79	

Sample Analyzed with Each Extraction Set (Sample Number)	Spike Level (ppb)	Results (ppb)	Recovery (%)
752, 848	0.5	0.49	98
926, 1243	0.5	0.47	94
591, 902	0.5	0.51	102
824	0.5	0.51	102
798	0.5	0.54	108
971, 1051, 1057, 1075, 1087, 1123, 1135, 1141, 1269, 1275	1.0	0.90	90
1069	0.5	0.51	102
1347	0.5	0.49	98
866	0.5	0.51	102
939, 946, 977, 1001, 1013, 1031, 1037	0.5	0.50	100
872, 892, 965, 983, 989, 1019, 1025, 1147, 1153, 1311, 1377, 1378, 1380	0.5	0.52	104
1105	0.5	0.44	88
1093, 1007, 995, 1381, 1335	0.5	0.51	102

UCL = upper control limit, UWL = upper warning limit, LWL = lower warning limit, LCL = lower control limit.

Table 16. Continuing quality control data (% recoveries) for the Winter 1991-92 San Joaquin River study.

Screen: Organophosphate | UCL = 120 | Sample Type: Surface Water
Analyte: Methyl Parathion OA | UWL = 112 | Lab: CDFA
MDL: 0.05 ppb | LWL = 79 | Chemist: Jean Hsu
LCL = 71

Sample Analyzed with Each Extraction Set (Sample Number)	Spike Level (ppb)	Results (ppb)	Recovery (%)
758, 896	0.5	0.48	96
776 ,812	0.5	0.46	92
884 ,1379	0.5	0.41	82
953, 960, 1043, 1081, 1099, 1111, 1117, 1365, 1371	0.5	0.59	118
1069	0.5	0.54	108

UCL = upper control limit, UWL = upper warning limit, LWL = lower warning limit, LCL = lower control limit.

Table 17. Continuing quality control data (% recoveries) for the Winter 1991-92 San Joaquin River study.

Screen: Organophosphate | UCL = 110 | Sample Type: Surface Water
Analyte: Phorate | UWL = 104 | Lab: CDFA
MDL: 0.05 ppb | LWL = 80 | Chemist: Jean Hsu
LCL = 74

Sample Analyzed with Each Extraction Set (Sample Number)	Spike Level (ppb)	Results (ppb)	Recovery (%)
758, 896	0.5	0.42	84
776, 812	0.5	0.42	84
884, 1379	0.5	0.46	92
953, 960, 1043, 1081, 1099, 1111, 1117, 1365, 1371	0.5	0.50	100
1069	0.5	0.38	76
872, 892, 965, 983, 989, 1019, 1025, 1147, 1153, 1311, 1377, 1378, 1380	0.5	0.52	104

UCL = upper control limit, UWL = upper warning limit, LWL = lower warning limit, LCL = lower control limit.

Table 18. Continuing quality control data (% recoveries) for the Winter 1991-92 San Joaquin River study.

Screen: Organophosphate | UCL = 125 | Sample Type: Surface Water
Analyte: Phosalone | UWL = 117 | Lab: CDFA
MDL: 0.05 ppb | LWL = 87 | Chemist: Jean Hsu
LCL = 79

Sample Analyzed with Each Extraction Set (Sample Number)	Spike Level (ppb)	Results (ppb)	Recovery (%)
926, 1243	0.5	0.48	96
758, 896	0.5	0.52	104
824	0.5	0.44	88
953, 960, 1043, 1081, 1099, 1111, 1117, 1365, 1371	0.5	0.50	100
971, 1051, 1057, 1075, 1087, 1123, 1135, 1141, 1269, 1275	0.5	0.45	90
939, 946, 977, 1001, 1013, 1031, 1037	0.5	0.48	96

UCL = upper control limit, UWL = upper warning limit, LWL = lower warning limit, LCL = lower control limit.

Table 19. Continuing quality control data (% recoveries) for the Winter 1991-92 San Joaquin River study.

Screen: Organophosphate | UCL = 129 | Sample Type: Surface Water
Analyte: Phosalone OA | UWL = 121 | Lab: CDFA
MDL: 0.05 ppb | LWL = 85 | Chemist: Jean Hsu
LCL = 77

Sample Analyzed with Each Extraction Set (Sample Number)	Spike Level (ppb)	Results (ppb)	Recovery (%)
758, 896	0.5	0.49	98
953, 960, 1043, 1081, 1099, 1111, 1117, 1365, 1371	0.5	0.60	120
971, 1051, 1057, 1075, 1087, 1123, 1135, 1141, 1269, 1275	0.5	0.49	98

UCL = upper control limit, UWL = upper warning limit, LWL = lower warning limit, LCL = lower control limit.

Appendix III. Continuing QC. Organophosphate Screen - Winter 1991-92

Table 20. Continuing quality control data for the Winter 1991-92 San Joaquin River study.

Screen: Organophosphate	UCL = 118	Sample Type: Surface Water
Analyte: Phosmet	UWL = 113	Lab: CDFA
MDL: 0.05 ppb	LWL = 95	Chemist: Jean Hsu
	LCL = 90	

Sample Analyzed with Each Extraction Set (Sample Number)	Spike Level (ppb)	Results (ppb)	Recovery (%)
752, 848	0.5	0.59	118
926, 1243	0.5	0.47	94
591, 902	0.5	0.54	108
824	0.5	0.53	106
798	0.5	0.56	112
971, 1051, 1057, 1075, 1087, 1123, 1135, 1141, 1269, 1275	1.0	1.03	103
1069	0.5	0.59	118
1347	0.5	0.53	106
866	0.5	0.54	108
939, 946, 977, 1001, 1013, 1031, 1037	0.5	0.51	102
872, 892, 965, 983, 989, 1019, 1025, 1147, 1153, 1311, 1377, 1378, 1380	0.5	0.53	106
1105	0.5	0.51	102
1093, 1007, 995, 1381, 1335	0.5	0.53	106

UCL = upper control limit, UWL = upper warning limit, LWL = lower warning limit, LCL = lower control limit.

Table 21. Continuing quality control data (% recoveries) for the Winter 1991-92 San Joaquin River study.

Screen: Organophosphate	UCL = 124	Sample Type: Surface Water
Analyte: Phosmet OA	UWL = 115	Lab: CDFA
MDL: 0.30 ppb	LWL = 79	Chemist: Jean Hsu
	LCL = 70	

Sample Analyzed with Each Extraction Set (Sample Number)	Spike Level (ppb)	Results (ppb)	Recovery (%)
758, 896	0.5	0.57	114
953, 960, 1043, 1081, 1099, 1111, 1117, 1365, 1371	0.5	0.53	106
971, 1051, 1057, 1075, 1087, 1123, 1135, 1141, 1269, 1275	0.5	0.53	106

UCL = upper control limit, UWL = upper warning limit, LWL = lower warning limit, LCL = lower control limit.

Table 1. Continuing quality control data for the Winter 1992-93 San Joaquin River study.

Screen: Organophosphate	UCL = 117	Sample Type: Surface Water
Analyte: Azinphos-methyl	UWL = 111	Lab: CDFA
MDL: 0.05 ppb	LWL = 87	Chemist: J. White
	LCL = 81	

Sample Analyzed with Each Extraction Set (Sample Number)	Spike Level (ppb)	Results (ppb)	Recovery %
2139	0.5	0.49	98
2307, 2309	0.5	0.50	100
2127	0.5	0.54	106
1521, 1893, 1911, 1971, 1977, 1989, 1995, 2019, 2025	0.5	0.68	136**
2049	0.5	0.65	130**
2253	0.5	0.58	116
2013, 2199	0.5	0.44	88
1875, 1899, 1935, 1941, 1947, 2007, 2085, 2091, 2097, 2145, 2193	0.5	0.67	134**
2206, 2211, 2217, 2259, 2265, 2271, 2277, 2283, 2289, 2295	0.5	0.56	112
1887	0.5	0.55	110
2103	0.5	0.53	106
1951, 1952, 2210, 2275, 2276, 2367, 2368, 2369	0.5	0.46	92
2161, 2239	0.5	0.59	118**

UCL = upper control limit, UWL = upper warning limit, LWL = lower warning limit, LCL = lower warning limit.

** Matrix spike recoveries fell above the upper control limit.

Table 2. Continuing quality control data for the Winter 1992-93 San Joaquin River study.

Screen: Organophosphate	UCL = 114	Sample Type: Surface Water
Analyte: Azinphos-methyl OA	UWL = 108	Lab: CDFA
MDL: 0.30 ppb	LWL = 84	Chemist: J. White
	LCL = 78	

Sample Analyzed with Each Extraction Set (Sample Number)	Spike Level (ppb)	Results (ppb)	Recovery %
1917, 2115, 2301	0.5	0.36	72*
1533,2031,2037,2043, 2055, 2061, 2067, 2073, 2109, 2121, 2169, 2175, 2181, 2187	0.5	0.54	108
1905	0.5	0.49	98

UCL = upper control limit, UWL = upper warning limit, LWL = lower warning limit, LCL = lower warning limit.

* Matrix spike recovery fell below the lower control limit.

Table 3. Continuing quality control data for the Winter 1992-93 San Joaquin River study.

Screen: Organophosphate	UCL = 116	Sample Type: Surface Water
Analyte: Chlorpyrifos	UWL = 110	Lab: CDFA
MDL: 0.05 ppb	LWL = 83	Chemist: J. White
	LCL = 76	

Sample Analyzed with Each Extraction Set (Sample Number)	Spike Level (ppb)	Results (ppb)	Recovery %
2139	0.5	0.51	102
2307, 2309	0.5	0.58	116
2127	0.5	0.61	122**
1521, 1893, 1911, 1971, 1977, 1989, 1995, 2019, 2025	0.5	0.61	122**
2049	0.5	0.63	126**
2253	0.5	0.47	94
2013, 2199	0.5	0.51	102
1875, 1899, 1935, 1941, 1947, 2007, 2085, 2091, 2097, 2145, 2193	0.5	0.52	104
2206, 2211, 2217, 2259, 2265, 2271, 2277, 2283, 2289, 2295	0.5	0.51	102
1887	0.5	0.55	110
2103	0.5	0.54	108
1951, 1952, 2210, 2275, 2276, 2367, 2368, 2369	0.5	0.47	94
2161, 2239	0.5	0.51	102

UCL = upper control limit, UWL = upper warning limit, LWL = lower warning limit, LCL = lower warning limit.

** Matrix spike recoveries fell above the upper control limit.

Table 4. Continuing quality control data for the Winter 1992-93 San Joaquin River study.

Screen: Organophosphate	UCL = 121	Sample Type: Surface Water
Analyte: Chlorpyrifos OA	UWL = 113	Lab: CDFA
MDL: 0.05 ppb	LWL = 80	Chemist: J. White
	LCL = 72	

Sample Analyzed with Each Extraction Set (Sample Number)	Spike Level (ppb)	Results (ppb)	Recovery %
1917, 2115, 2301	0.5	0.43	86
1533,2031,2037,2043, 2055, 2061, 2067, 2073, 2109, 2121, 2169, 2175, 2181, 2187	0.5	0.60	120
1905	0.5	0.45	90
2247, 2340, 2351, 2352	0.5	0.54	108

UCL = upper control limit, UWL = upper warning limit, LWL = lower warning limit, LCL = lower warning limit.

Table 5. Continuing quality control data for the Winter 1992-93 San Joaquin River study.

Screen: Organophosphate	UCL = 123	Sample Type: Surface Water
Analyte: DDVP	UWL = 115	Lab: CDFA
MDL: 0.05 ppb	LWL = 82	Chemist: J. White
	LCL = 73	

Sample Analyzed with Each Extraction Set (Sample Number)	Spike Level (ppb)	Results (ppb)	Recovery %
2139	0.5	0.49	98
2307, 2309	0.5	0.47	94
2127	0.5	0.42	84
1521, 1893, 1911, 1971, 1977, 1989, 1995, 2019, 2025	0.5	0.54	108
2049	0.5	0.54	108
2253	0.5	0.52	104
2013, 2199	0.5	0.49	98
1875, 1899, 1935, 1941, 1947, 2007, 2085, 2091, 2097, 2145, 2193	0.5	0.46	92
2206, 2211, 2217, 2259, 2265, 2271, 2277, 2283, 2289, 2295	0.5	0.47	94
1887	0.5	0.50	100
2103	0.5	0.45	90
1951, 1952, 2210, 2275, 2276, 2367, 2368, 2369	0.5	0.46	92
2161, 2239	0.5	0.49	96

UCL = upper control limit, UWL = upper warning limit, LWL = lower warning limit, LCL = lower warning limit.

Table 6. Continuing quality control data for the Winter 1992-93 San Joaquin River study.

Screen: Organophosphate	UCL = 122	Sample Type: Surface Water
Analyte: Diazinon (OP Screen)	UWL = 113	Lab: CDFA
MDL: 0.05 ppb	LWL = 78	Chemist: J. White
	LCL = 69	

Sample Analyzed with Each Extraction Set (Sample Number)	Spike Level (ppb)	Results (ppb)	Recovery %
2139	0.5	0.46	92
2307, 2309	0.5	0.49	98
2127	0.5	0.46	92
1521, 1893, 1911, 1971, 1977, 1989, 1995, 2019, 2025	0.5	0.50	100
2049	0.5	0.53	106
2253	0.5	0.48	96
2013, 2199	0.5	0.50	100
1875, 1899, 1935, 1941, 1947, 2007, 2085, 2091, 2097, 2145, 2193	0.5	0.52	104
2206, 2211, 2217, 2259, 2265, 2271, 2277, 2283, 2289, 2295	0.5	0.51	102
1887	0.5	0.53	106
2103	0.5	0.48	96
1951, 1952, 2210, 2275, 2276, 2367, 2368, 2369	0.5	0.47	94
2161, 2239	0.5	0.54	108

UCL = upper control limit, UWL = upper warning limit, LWL = lower warning limit, LCL = lower warning limit.

Table 7. Continuing quality control data for the Winter 1992-93 San Joaquin River study.

Screen: Organophosphate	UCL = 119	Sample Type: Surface Water
Analyte: Diazinon OA (OP Screen)	UWL = 112	Lab: CDFA
MDL: 0.05 ppb	LWL = 83	Chemist: J. White
	LCL = 76	

Sample Analyzed with Each Extraction Set (Sample Number)	Spike Level (ppb)	Results (ppb)	Recovery %
1923	0.5	0.56	112
1929, 2313, 2316	0.5	0.52	104
1881, 2323	0.5	0.51	102
2179, 2229, 2399	0.5	0.52	104
2133, 2157, 2163, 2223, 2235, 2347, 2349, 2350	0.5	0.45	90

UCL = upper control limit, UWL = upper warning limit, LWL = lower warning limit, LCL = lower warning limit.

Table 8. Continuing quality control data for the Winter 1992-93 San Joaquin River study.

Screen: Organophosphate	UCL = 116	Sample Type: Surface Water
Analyte: Dimethoate	UWL = 110	Lab: CDFA
MDL: 0.05 ppb	LWL = 86	Chemist: J. White
	LCL = 80	

Sample Analyzed with Each Extraction Set (Sample Number)	Spike Level (ppb)	Results (ppb)	Recovery %
2139	0.5	0.44	88
2307, 2309	0.5	0.50	100
2127	0.5	0.50	100
1521, 1893, 1911, 1971, 1977, 1989, 1995, 2019, 2025	0.5	0.56	112
2049	0.5	0.55	110
2253	0.5	0.57	114
2013, 2199	0.5	0.53	106
1875, 1899, 1935, 1941, 1947, 2007, 2085, 2091, 2097, 2145, 2193	0.5	0.51	102
2206, 2211, 2217, 2259, 2265, 2271, 2277, 2283, 2289, 2295	0.5	0.57	114
1887	0.5	0.54	108
2103	0.5	0.47	94
1951, 1952, 2210, 2275, 2276, 2367, 2368, 2369	0.5	0.51	102
2161, 2239	0.5	0.49	98

UCL = upper control limit, UWL = upper warning limit, LWL = lower warning limit, LCL = lower warning limit.

Table 9. Continuing quality control data for the Winter 1992-93 San Joaquin River study.

Screen: Organophosphate	UCL = 105	Sample Type: Surface Water
Analyte: Ethoprop	UWL = 103	Lab: CDFA
MDL: 0.05 ppb	LWL = 93	Chemist: J. White
	LCL = 91	

Sample Analyzed with Each Extraction Set (Sample Number)	Spike Level (ppb)	Results (ppb)	Recovery %
2253, 2395	0.5	0.51	102

UCL = upper control limit, UWL = upper warning limit, LWL = lower warning limit, LCL = lower warning limit.

Table 10. Continuing quality control data for the Winter 1992-93 San Joaquin River study.

Screen: Organophosphate	UCL = 108	Sample Type: Surface Water
Analyte: Ethyl Parathion	UWL = 104	Lab: CDFA
MDL: 0.05 ppb	LWL = 89	Chemist: J. White
	LCL = 86	

Sample Analyzed with Each Extraction Set (Sample Number)	Spike Level (ppb)	Results (ppb)	Recovery %
1923	0.5	0.53	106
1929, 2313, 2316	0.5	0.52	104
1881, 2323	0.5	0.49	98
2179, 2229, 2399	0.5	0.51	102
2133, 2157, 2163, 2223, 2235, 2347, 2349, 2350	0.5	0.45	90

UCL = upper control limit, UWL = upper warning limit, LWL = lower warning limit, LCL = lower warning limit.

Table 11. Continuing quality control data for the Winter 1992-93 San Joaquin River study.

Screen: Organophosphate	UCL = 113	Sample Type: Surface Water
Analyte: Ethyl Parathion OA	UWL = 107	Lab: CDFA
MDL: 0.05 ppb	LWL = 83	Chemist: J. White
	LCL = 77	

Sample Analyzed with Each Extraction Set (Sample Number)	Spike Level (ppb)	Results (ppb)	Recovery %
1917, 2115, 2301	0.5	0.49	98
1533,2031,2037,2043, 2055, 2061, 2067, 2073, 2109, 2121, 2169, 2175, 2181, 2187	0.5	0.51	102
1905	0.5	0.49	98
2247, 2340, 2351, 2352	0.5	0.50	100

UCL = upper control limit, UWL = upper warning limit, LWL = lower warning limit, LCL = lower warning limit.

Table 12. Continuing quality control data for the Winter 1992-93 San Joaquin River study.

Screen: Organophosphate	UCL = 102	Sample Type: Surface Water
Analyte: Fonofos	UWL = 100	Lab: CDFA
MDL: 0.05 ppb	LWL = 94	Chemist: J. White
	LCL = 92	

Sample Analyzed with Each Extraction Set (Sample Number)	Spike Level (ppb)	Results (ppb)	Recovery %
2253, 2395	0.5	0.50	100

UCL = upper control limit, UWL = upper warning limit, LWL = lower warning limit, LCL = lower warning limit.

Table 13. Continuing quality control data for the Winter 1992-93 San Joaquin River study.

Screen: Organophosphate	UCL = 114	Sample Type: Surface Water
Analyte: Malathion	UWL = 109	Lab: CDFA
MDL: 0.05 ppb	LWL = 87	Chemist: J. White
	LCL = 81	

Sample Analyzed with Each Extraction Set (Sample Number)	Spike Level (ppb)	Results (ppb)	Recovery %
2139	0.5	0.46	92
2307, 2309	0.5	0.51	102
2127	0.5	0.58	116**
1521, 1893, 1911, 1971, 1977, 1989, 1995, 2019, 2025	0.5	0.57	114
2049	0.5	0.56	112
2253	0.5	0.59	118**
2013, 2199	0.5	0.56	112
1875, 1899, 1935, 1941, 1947, 2007, 2085, 2091, 2097, 2145, 2193	0.5	0.47	94
2206, 2211, 2217, 2259, 2265, 2271, 2277, 2283, 2289, 2295	0.5	0.56	112
1887	0.5	0.54	108
2103	0.5	0.40	80*
1951, 1952, 2210, 2275, 2276, 2367, 2368, 2369	0.5	0.49	98
2161, 2239	0.5	0.53	106

UCL = upper control limit, UWL = upper warning limit, LWL = lower warning limit, LCL = lower warning limit.

* Matrix spike recovery fell below the control limits.

** Matrix spike recoveries fell above the control limits.

Table 14. Continuing quality control data for the Winter 1992-93 San Joaquin River study.

Screen: Organophosphate	UCL = 124	Sample Type: Surface Water
Analyte: Malathion OA	UWL = 117	Lab: CDFA
MDL: 0.05 ppb	LWL = 88	Chemist: J. White
	LCL = 80	

Sample Analyzed with Each Extraction Set (Sample Number)	Spike Level (ppb)	Results (ppb)	Recovery %
1923	0.5	0.48	96
1929, 2313, 2316	0.5	0.50	100
1881, 2323	0.5	0.52	104
2179, 2229, 2399	0.5	0.52	104
2133, 2157, 2163, 2223, 2235, 2347, 2349, 2350	0.5	0.45	90

UCL = upper control limit, UWL = upper warning limit, LWL = lower warning limit, LCL = lower warning limit.

Table 15. Continuing quality control data for the Winter 1992-93 San Joaquin River study.

Screen: Organophosphate	UCL = 124	Sample Type: Surface Water
Analyte: Methidathion	UWL = 116	Lab: CDFA
MDL: 0.05 ppb	LWL = 83	Chemist: J. White
	LCL = 75	

Sample Analyzed with Each Extraction Set (Sample Number)	Spike Level (ppb)	Results (ppb)	Recovery %
2139	0.5	0.44	88
2307, 2309	0.5	0.51	102
2127	0.5	0.45	90
1521, 1893, 1911, 1971, 1977, 1989, 1995, 2019, 2025	0.5	0.54	108
2049	0.5	0.56	112
2253	0.5	0.53	106
2013, 2199	0.5	0.54	108
1875, 1899, 1935, 1941, 1947, 2007, 2085, 2091, 2097, 2145, 2193	0.5	0.55	110
2206, 2211, 2217, 2259, 2265, 2271, 2277, 2283, 2289, 2295	0.5	0.53	106
1887	0.5	0.59	118
2103	0.5	0.46	92
1951, 1952, 2210, 2275, 2276, 2367, 2368, 2369	0.5	0.52	104
2161, 2239	0.5	0.51	102

UCL = upper control limit, UWL = upper warning limit, LWL = lower warning limit, LCL = lower warning limit.

Table 16. Continuing quality control data for the Winter 1992-93 San Joaquin River study.

Screen: Organophosphate	UCL = 117	Sample Type: Surface Water
Analyte: Methidathion OA	UWL = 111	Lab: CDFA
MDL: 0.05 ppb	LWL = 85	Chemist: J. White
	LCL = 78	

Sample Analyzed with Each Extraction Set (Sample Number)	Spike Level (ppb)	Results (ppb)	Recovery %
1917, 2115, 2301	0.5	0.44	88
1533,2031,2037,2043, 2055, 2061, 2067, 2073, 2109, 2121, 2169, 2175, 2181, 2187	0.5	0.49	98
1905	0.5	0.48	96
2247, 2340, 2351, 2352	0.5	0.49	98

UCL = upper control limit, UWL = upper warning limit, LWL = lower warning limit, LCL = lower warning limit.

Table 17. Continuing quality control data for the Winter 1992-93 San Joaquin River study.

Screen: Organophosphate	UCL = 116	Sample Type: Surface Water
Analyte: Methyl Parathion	UWL = 110	Lab: CDFA
MDL: 0.05 ppb	LWL = 85	Chemist: J. White
	LCL = 79	

Sample Analyzed with Each Extraction Set (Sample Number)	Spike Level (ppb)	Results (ppb)	Recovery %
2139	0.5	0.43	86
2307, 2309	0.5	0.49	98
2127	0.5	0.52	104
1521, 1893, 1911, 1971, 1977, 1989, 1995, 2019, 2025	0.5	0.53	106
2049	0.5	0.52	104
2253	0.5	0.46	92
2013, 2199	0.5	0.48	96
1875, 1899, 1935, 1941, 1947, 2007, 2085, 2091, 2097, 2145, 2193	0.5	0.51	102
2206, 2211, 2217, 2259, 2265, 2271, 2277, 2283, 2289, 2295	0.5	0.52	104
1887	0.5	0.56	112
2103	0.5	0.49	98
1951, 1952, 2210, 2275, 2276, 2367, 2368, 2369	0.5	0.49	98
2161, 2239	0.5	0.53	106

UCL = upper control limit, UWL = upper warning limit, LWL = lower warning limit, LCL = lower warning limit.

Table 18. Continuing quality control data for the Winter 1992-93 San Joaquin River study.

Screen: Organophosphate	UCL = 120	Sample Type: Surface Water
Analyte: Methyl Parathion OA	UWL = 112	Lab: CDFA
MDL: 0.05 ppb	LWL = 79	Chemist: J. White
	LCL = 71	

Sample Analyzed with Each Extraction Set (Sample Number)	Spike Level (ppb)	Results (ppb)	Recovery %
1917, 2115, 2301	0.5	0.48	96
1533,2031,2037,2043, 2055, 2061, 2067, 2073, 2109, 2121, 2169, 2175, 2181, 2187	0.5	0.49	98
1905	0.5	0.48	96
2247, 2340, 2351, 2352	0.5	0.53	106

UCL = upper control limit, UWL = upper warning limit, LWL = lower warning limit, LCL = lower warning limit.

Table 19. Continuing quality control data for the Winter 1992-93 San Joaquin River study.

Screen: Organophosphate	UCL = 110	Sample Type: Surface Water
Analyte: Phorate	UWL = 104	Lab: CDFA
MDL: 0.05 ppb	LWL = 80	Chemist: J. White
	LCL = 74	

Sample Analyzed with Each Extraction Set (Sample Number)	Spike Level (ppb)	Results (ppb)	Recovery %
1917, 2115, 2301	0.5	0.38	76
1533,2031,2037,2043, 2055, 2061, 2067, 2073, 2109, 2121, 2169, 2175, 2181, 2187	0.5	0.49	98
1905	0.5	0.49	98
2247, 2340, 2351, 2352	0.5	0.47	94

UCL = upper control limit, UWL = upper warning limit, LWL = lower warning limit, LCL = lower warning limit.

Table 20. Continuing quality control data for the Winter 1992-93 San Joaquin River study.

Screen: Organophosphate	UCL = 125	Sample Type: Surface Water
Analyte: Phosalone	UWL = 117	Lab: CDFA
MDL: 0.05 ppb	LWL = 87	Chemist: J. White
	LCL = 79	

Sample Analyzed with Each Extraction Set (Sample Number)	Spike Level (ppb)	Results (ppb)	Recovery %
1923	0.5	0.46	92
1929, 2313, 2316	0.5	0.52	104
1881, 2323	0.5	0.49	98
2179, 2229, 2399	0.5	0.51	102
2133, 2157, 2163, 2223, 2235, 2347, 2349, 2350	0.5	0.45	90

UCL = upper control limit, UWL = upper warning limit, LWL = lower warning limit, LCL = lower warning limit.

Table 21. Continuing quality control data for the Winter 1992-93 San Joaquin River study.

Screen: Organophosphate	UCL = 129	Sample Type: Surface Water
Analyte: Phosalone OA	UWL = 121	Lab: CDFA
MDL: 0.05 ppb	LWL = 85	Chemist: J. White
	LCL = 77	

Sample Analyzed with Each Extraction Set (Sample Number)	Spike Level (ppb)	Results (ppb)	Recovery %
1923	0.5	0.43	86
1929, 2313, 2316	0.5	0.47	94
1881, 2323	0.5	0.54	108
2133, 2157, 2163, 2223, 2235, 2347, 2349, 2350	0.5	0.43	86

UCL = upper control limit, UWL = upper warning limit, LWL = lower warning limit, LCL = lower warning limit.

Table 22. Continuing quality control data for the Winter 1992-93 San Joaquin River study.

Screen: Organophosphate	UCL = 118	Sample Type: Surface Water
Analyte: Phosmet	UWL = 113	Lab: CDFA
MDL: 0.05 ppb	LWL = 95	Chemist: J. White
	LCL = 90	

Sample Analyzed with Each Extraction Set (Sample Number)	Spike Level (ppb)	Results (ppb)	Recovery %
2139	0.5	0.44	88*
2307, 2309	0.5	0.53	106
2127	0.5	0.50	100
1521, 1893, 1911, 1971, 1977, 1989, 1995, 2019, 2025	0.5	0.55	110
2049	0.5	0.60	120**
2253	0.5	0.54	108
2013, 2199	0.5	0.56	112
1875, 1899, 1935, 1941, 1947, 2007, 2085, 2091, 2097, 2145, 2193	0.5	0.53	106
2206, 2211, 2217, 2259, 2265, 2271, 2277, 2283, 2289, 2295	0.5	0.64	128**
1887	0.5	0.54	108
2103	0.5	0.51	102
1951, 1952, 2210, 2275, 2276, 2367, 2368, 2369	0.5	0.49	98
2161, 2239	0.5	0.50	100

UCL = upper control limit, UWL = upper warning limit, LWL = lower warning limit, LCL = lower warning limit.

* Matrix spike recovery fell below the control limits.

** Matrix spike recoveries fell above the control limits.

Table 23. Continuing quality control data for the Winter 1992-93 San Joaquin River study.

Screen: Organophosphate	UCL = 124	Sample Type: Surface Water
Analyte: Phosmet OA	UWL = 115	Lab: CDFA
MDL: 0.30 ppb	LWL = 79	Chemist: J. White
	LCL = 70	

Sample Analyzed with Each Extraction Set (Sample Number)	Spike Level (ppb)	Results (ppb)	Recovery %
1923	0.5	0.39	78
1929, 2313, 2316	0.5	0.39	78
1881, 2323	0.5	0.58	116
2179, 2229, 2399	0.5	0.44	88
2133, 2157, 2163, 2223, 2235, 2347, 2349, 2350	0.5	0.45	90

UCL = upper control limit, UWL = upper warning limit, LWL = lower warning limit, LCL = lower warning limit.

Table 1. Continuing quality control data for the Winter 1991-92 San Joaquin River study.

Screen: Carbamate | UCL = 117 | Sample Type: Surface Water
Analyte: Aldicarb | UWL = 109 | Lab: CDFA
MDL: 0.05 ppb | LWL = 76 | Chemist: S. Richman
LCL = 68

Sample Analyzed with Each Extraction Set (Sample Number)	Spike Level (ppb)	Results (ppb)	Recovery (%)
753, 849, 927	0.1	0.085	85
759, 897, 588, 903	0.1	0.088	88
825, 594	0.1	0.102	102
777, 813	0.1	0.092	92
795	0.1	0.102	102
885	0.1	0.081	81
954, 961, 1044, 1082, 1100, 1112, 1118, 1366, 1372	0.1	0.093	93
972, 1052, 1058, 1076, 1124, 1136, 1142, 1270, 1276	0.1	0.071	71
1070, 1088, 1306, 1348	0.1	0.070	70
867, 940, 947, 978, 996, 1002, 1008, 1014, 1038, 1094	0.1	0.086	86
873, 891, 966, 984, 990, 1020, 1026, 1032, 1148, 1154, 1312	0.1	0.089	89
1106	0.1	0.076	76
1336	0.1	0.093	93

UCL = upper control limit, UWL = upper warning limit, LWL = lower warning limit, LCL = lower control limit.

Table 2. Continuing quality control data for the Winter 1991-92 San Joaquin River study.

Screen: Carbamate | UCL = 87 | Sample Type: Surface Water
Analyte: Aldicarb sulfoxide | UWL = 81 | Lab: CDFA
MDL: 0.05 ppb | LWL = 57 | Chemist: S. Richman
LCL = 50

Sample Analyzed with Each Extraction Set (Sample Number)	Spike Level (ppb)	Results (ppb)	Recovery (%)
753, 849, 927	0.1	0.093	93**
759, 897, 588, 903	0.1	0.070	70
825, 594	0.1	0.082	82
777, 813	0.1	0.072	72
795	0.1	0.088	88**
885	0.1	0.070	70
954, 961, 1044, 1082, 1100, 1112, 1118, 1366, 1372	0.1	0.092	92**
972, 1052, 1058, 1076, 1124, 1136, 1142, 1270, 1276	0.1	0.070	70
1070, 1088, 1306, 1348	0.1	0.110	110**
867, 940, 947, 978, 996, 1002, 1008, 1014, 1038, 1094	0.1	0.082	82
873, 891, 966, 984, 990, 1020, 1026, 1032, 1148, 1154, 1312	0.1	0.084	84
1106	0.1	0.091	91**
1336	0.1	0.065	65

UCL = upper control limit, UWL = upper warning limit, LWL = lower warning limit, LCL = lower control limit.
** Matrix spike recoveries fell above the upper control limit.

Table 3. Continuing quality control data for the Winter 1991-92 San Joaquin River study.

Screen: Carbamate | UCL = 116 | Sample Type: Surface Water
Analyte: Aldicarb sulfone | UWL = 111 | Lab: CDFA
MDL: 0.05 ppb | LWL = 88 | Chemist: S. Richman
LCL = 82

Sample Analyzed with Each Extraction Set (Sample Number)	Spike Level (ppb)	Results (ppb)	Recovery (%)
753, 849, 927	0.1	0.089	89
759, 897, 588, 903	0.1	0.092	92
825, 594	0.1	0.093	93
777, 813	0.1	0.080	80*
795	0.1	0.097	97
885	0.1	0.096	96
954, 961, 1044, 1082, 1100, 1112, 1118, 1366, 1372	0.1	0.117	117**
972, 1052, 1058, 1076, 1124, 1136, 1142, 1270, 1276	0.1	0.088	88
1070, 1088, 1306, 1348	0.1	0.079	79*
867, 940, 947, 978, 996, 1002, 1008, 1014, 1038, 1094	0.1	0.099	99
873, 891, 966, 984, 990, 1020, 1026, 1032, 1148, 1154, 1312	0.1	0.094	94
1106	0.1	0.097	97

UCL = upper control limit, UWL = upper warning limit, LWL = lower warning limit, LCL = lower control limit.
* Matrix spike recovery fell below the lower control limit. ** Matrix spike recovery fell above the upper control limit.

Table 4. Continuing quality control data for the Winter 1991-92 San Joaquin River study.

Screen: Carbamate | UCL = 124 | Sample Type: Surface Water
Analyte: Carbaryl | UWL = 116 | Lab: CDFA
MDL: 0.05 ppb | LWL = 83 | Chemist: S. Richman
LCL = 75

Sample Analyzed with Each Extraction Set (Sample Number)	Spike Level (ppb)	Results (ppb)	Recovery (%)
753, 849, 927	0.10	0.103	103
759, 897, 588, 903	0.10	0.096	96
825, 594	0.10	0.100	100
777, 813	0.10	0.094	94
795	0.10	0.091	91
885	0.10	0.094	94
954, 961, 1044, 1082, 1100, 1112, 1118, 1366, 1372	0.10	0.091	91
972, 1052, 1058, 1076, 1124, 1136, 1142, 1270, 1276	0.10	0.083	83
1070, 1088, 1306, 1348	0.10	0.083	83
867, 940, 947, 978, 996, 1002, 1008, 1014, 1038, 1094	0.10	0.089	89
873, 891, 966, 984, 990, 1020, 1026, 1032, 1148, 1154, 1312	0.10	0.091	91
1106	0.10	0.098	98
1336	0.10	0.104	104

UCL = upper control limit, UWL = upper warning limit, LWL = lower warning limit, LCL = lower control limit.

Table 5. Continuing quality control data for the Winter 1991-92 San Joaquin River study.

Screen: Carbamate | UCL = 113 | Sample Type: Surface Water
Analyte: Carbofuran | UWL = 108 | Lab: CDFA
MDL: 0.05 ppb | LWL = 89 | Chemist: S. Richman
LCL = 84

Sample Analyzed with Each Extraction Set (Sample Number)	Spike Level (ppb)	Results (ppb)	Recovery (%)
753, 849, 927	0.1	0.088	88
759, 897, 588, 903	0.1	0.102	102
825, 594	0.1	0.096	96
777, 813	0.1	0.100	100
795	0.1	0.103	103
885	0.1	0.100	100
954, 961, 1044, 1082, 1100, 1112, 1118, 1366, 1372	0.1	0.104	104
972, 1052, 1058, 1076, 1124, 1136, 1142, 1270, 1276	0.1	0.102	102
1070, 1088, 1306, 1348	0.1	0.088	88
867, 940, 947, 978, 996, 1002, 1008, 1014, 1038, 1094	0.1	0.096	96
873, 891, 966, 984, 990, 1020, 1026, 1032, 1148, 1154, 1312	0.1	0.097	97
1106	0.1	0.104	104

UCL = upper control limit, UWL = upper warning limit, LWL = lower warning limit, LCL = lower control limit.

Table 6. Continuing quality control data for the Winter 1991-92 San Joaquin River study.

Screen: Carbamate | UCL = 126 | Sample Type: Surface Water
Analyte: 3- Hydroxy carbofuran | UWL = 117 | Lab: CDFA
MDL: 0.05 ppb | LWL = 82 | Chemist: S. Richman
LCL = 73

Sample Analyzed with Each Extraction Set (Sample Number)	Spike Level (ppb)	Results (ppb)	Recovery (%)
753, 849, 927	0.1	0.093	93
759, 897, 588, 903	0.1	0.094	94
825, 594	0.1	0.108	108
777, 813	0.1	0.094	94
795	0.1	0.096	96
885	0.1	0.099	99
954, 961, 1044, 1082, 1100, 1112, 1118, 1366, 1372	0.1	0.093	93
972, 1052, 1058, 1076, 1124, 1136, 1142, 1270, 1276	0.1	0.119	119
1070, 1088, 1306, 1348	0.1	0.103	103
867, 940, 947, 978, 996, 1002, 1008, 1014, 1038, 1094	0.1	0.094	94
873, 891, 966, 984, 990, 1020, 1026, 1032, 1148, 1154, 1312	0.1	0.092	92
1106	0.1	0.103	103

UCL = upper control limit, UWL = upper warning limit, LWL = lower warning limit, LCL = lower control limit.

Table 7. Continuing quality control data for the Winter 1991-92 San Joaquin River study.

Screen: Carbamate | UCL = 120 | Sample Type: Surface Water
Analyte: Methiocarb | UWL = 113 | Lab: CDFA
MDL: 0.05 ppb | LWL = 84 | Chemist: S. Richman
LCL = 76

Sample Analyzed with Each Extraction Set (Sample Number)	Spike Level (ppb)	Results (ppb)	Recovery (%)
753, 849, 927	0.1	0.094	94
759, 897, 588, 903	0.1	0.092	92
825, 594	0.1	0.101	101
777, 813	0.1	0.082	82
795	0.1	0.090	90
885	0.1	0.102	102
954, 961, 1044, 1082, 1100, 1112, 1118, 1366, 1372	0.1	0.098	98
972, 1052, 1058, 1076, 1124, 1136, 1142, 1270, 1276	0.1	0.097	97
1070, 1088, 1306, 1348	0.1	0.095	95
867, 940, 947, 978, 996, 1002, 1008, 1014, 1038, 1094	0.1	0.106	106
873, 891, 966, 984, 990, 1020, 1026, 1032, 1148, 1154, 1312	0.1	0.092	92
1106	0.1	0.108	108

UCL = upper control limit, UWL = upper warning limit, LWL = lower warning limit, LCL = lower control limit.

Table 8. Continuing quality control data for the Winter 1991-92 San Joaquin River study.

Screen: Carbamate | UCL = 123 | Sample Type: Surface Water
Analyte: Methomyl | UWL = 114 | Lab: CDFA
MDL: 0.05 ppb | LWL = 79 | Chemist: S. Richman
LCL = 70

Sample Analyzed with Each Extraction Set (Sample Number)	Spike Level (ppb)	Results (ppb)	Recovery (%)
753, 849, 927	0.1	0.094	94
759, 897, 588, 903	0.1	0.094	94
825, 594	0.1	0.104	104
777, 813	0.1	0.076	76
795	0.1	0.104	104
885	0.1	0.102	102
954, 961, 1044, 1082, 1100, 1112, 1118, 1366, 1372	0.1	0.108	108
972, 1052, 1058, 1076, 1124, 1136, 1142, 1270, 1276	0.1	0.089	89
1070, 1088, 1306, 1348	0.1	0.094	94
867, 940, 947, 978, 996, 1002, 1008, 1014, 1038, 1094	0.1	0.094	94
873, 891, 966, 984, 990, 1020, 1026, 1032, 1148, 1154, 1312	0.1	0.096	96
1106	0.1	0.091	91

UCL = upper control limit, UWL = upper warning limit, LWL = lower warning limit, LCL = lower control limit.

Table 9. Continuing quality control data for the Winter 1991-92 San Joaquin River study.

Screen: Carbamate | UCL = 130 | Sample Type: Surface Water
Analyte: Oxamyl | UWL = 119 | Lab: CDFA
MDL: 0.05 ppb | LWL = 77 | Chemist: S. Richman
LCL = 66

Sample Analyzed with Each Extraction Set (Sample Number)	Spike Level (ppb)	Results (ppb)	Recovery (%)
753, 849, 927	0.1	0.086	86
759, 897, 588, 903	0.1	0.094	94
825, 594	0.1	0.080	80
777, 813	0.1	0.096	96
795	0.1	0.102	102
885	0.1	0.084	84
954, 961, 1044, 1082, 1100, 1112, 1118, 1366, 1372	0.1	0.097	97
972, 1052, 1058, 1076, 1124, 1136, 1142, 1270, 1276	0.1	0.090	90
1070, 1088, 1306, 1348	0.1	0.089	89
867, 940, 947, 978, 996, 1002, 1008, 1014, 1038, 1094	0.1	0.085	85
873, 891, 966, 984, 990, 1020, 1026, 1032, 1148, 1154, 1312	0.1	0.104	104
1106	0.1	0.106	106
1336	0.1	0.102	102

UCL = upper control limit, UWL = upper warning limit, LWL = lower warning limit, LCL = lower control limit.

Appendix III. Continuing QC. Carbamate Screen - Winter 1992-93

Table 1. Continuing quality control data for the Winter 1992-93 San Joaquin River study.

Screen: Carbamate | UCL = 117 | Sample Type: Surface Water
Analyte: Aldicarb | UWL = 109 | Lab: CDFA
MDL: 0.05 ppb | LWL = 76 | Chemist: S. Richman
LCL = 68

Sample Analyzed with Each Extraction Set (Sample Number)	Spike Level (ppb)	Results (ppb)	Recovery (%)
2140	0.10	0.081	81
1918, 2116	0.10	0.089	89
2308, 2310	0.10	0.080	80
1930	0.10	0.076	76
2020, 2110, 1978, 2056, 2182, 1534, 2032, 1996, 2074	0.10	0.077	77
2068, 2062, 2188, 2122, 1522, 2038, 1912, 1894	0.10	0.080	80
1972, 1990, 2050	0.10	0.089	89
1884	0.10	0.078	78
2254	0.10	0.077	77
2014, 2200	0.10	0.096	96
2230	0.10	0.087	87
1906	0.10	0.079	79
1936, 1948, 2092, 2098, 2146, 2207, 2212, 2260, 2278, 2290, 2296	0.10	0.089	89
2134, 2158, 2164, 2224, 2236	0.10	0.087	87
1888	0.10	0.094	94
2104	0.10	0.083	83

UCL = upper control limit, UWL = upper warning limit, LWL = lower warning limit, LCL = lower control limit.

Table 2. Continuing quality control data for the Winter 1992-93 San Joaquin River study.

Screen: Carbamate | UCL = 87 | Sample Type: Surface Water
Analyte: Aldicarb sulfoxide | UWL = 81 | Lab: CDFA
MDL: 0.05 ppb | LWL = 57 | Chemist: S. Richman
LCL = 50

Sample Analyzed with Each Extraction Set (Sample Number)	Spike Level (ppb)	Results (ppb)	Recovery (%)
2140	0.10	0.076	76
1918, 2116	0.10	0.070	70
2308, 2310	0.10	0.082	82
1930	0.10	0.087	87
2020, 2110, 1978, 2056, 2182, 1534, 2032, 1996, 2074	0.10	0.078	78
2068, 2062, 2188, 2122, 1522, 2038, 1912, 1894	0.10	0.094	94**
1972, 1990, 2050	0.10	0.076	76
1884	0.10	0.086	86
2254	0.10	0.074	74
2014, 2200	0.10	0.077	77
2230	0.10	0.072	72
1906	0.10	0.071	71
1936, 1948, 2092, 2098, 2146, 2207, 2212, 2260, 2278, 2290, 2296	0.10	0.085	85
2134, 2158, 2164, 2224, 2236	0.10	0.086	86
1888	0.10	0.074	74
2104	0.10	0.075	75

UCL = upper control limit, UWL = upper warning limit, LWL = lower warning limit, LCL = lower control limit.
** Matrix spike recovery fell above the upper control limit.

Table 3. Continuing quality control data for the Winter 1992-93 San Joaquin River study.

Screen: Carbamate
Analyte: Aldicarb sulfone
MDL: 0.05 ppb

UCL = 116
UWL = 111
LWL = 88
LCL = 82

Sample Type: Surface Water
Lab: CDFA
Chemist: S. Richman

Sample Analyzed with Each Extraction Set (Sample Number)	Spike Level (ppb)	Results (ppb)	Recovery (%)
2140	0.10	0.099	99
1924	0.10	0.082	82
1918, 2116	0.10	0.091	91
2308, 2310	0.10	0.098	98
2128	0.10	0.099	99
1930	0.10	0.094	94
2020, 2110, 1978, 2056, 2182, 1534, 2032, 1996, 2074	0.10	0.083	83
2068, 2062, 2188, 2122, 1522, 2038, 1912, 1894	0.10	0.082	82
2026, 2044, 2170, 2176	0.10	0.076	76*
1972, 1990, 2050	0.10	0.094	94
1884	0.10	0.091	91
2254	0.10	0.092	92
2230	0.10	0.093	93
1906	0.10	0.097	97
1876, 1900, 1942, 2008, 2086, 2194, 2218, 2266, 2272, 2284	0.10	0.096	96
1936, 1948, 2092, 2098, 2146, 2207, 2212, 2260, 2278, 2290, 2296	0.10	0.088	88
2134, 2158, 2164, 2224, 2236	0.10	0.093	93
2248	0.10	0.080	80
1888	0.10	0.097	97
2104	0.10	0.088	88
2197	0.10	0.085	85

UCL = upper control limit, UWL = upper warning limit, LWL = lower warning limit, LCL = lower control limit.
* Matrix spike recovery fell below the lower control limit.

Table 4. Continuing quality control data for the Winter 1992-93 San Joaquin River study.

Screen: Carbamate
Analyte: Carbaryl
MDL: 0.05 ppb

UCL = 124
UWL = 116
LWL = 83
LCL = 75

Sample Type: Surface Water
Lab: CDFA
Chemist: S. Richman

Sample Analyzed with Each Extraction Set (Sample Number)	Spike Level (ppb)	Results (ppb)	Recovery (%)
2140	0.10	0.091	91
1918, 2116	0.10	0.097	97
2308, 2310	0.10	0.088	88
1930	0.10	0.083	83
2020, 2110, 1978, 2056, 2182, 1534, 2032, 1996, 2074	0.10	0.082	82
2068, 2062, 2188, 2122, 1522, 2038, 1912, 1894	0.10	0.087	87
1972, 1990, 2050	0.10	0.094	94
1884	0.10	0.091	91
2254	0.10	0.095	95
2014, 2200	0.10	0.102	102
2230	0.10	0.088	88
1906	0.10	0.083	83
1936, 1948, 2092, 2098, 2146, 2207, 2212, 2260, 2278, 2290, 2296	0.10	0.094	94
2134, 2158, 2164, 2224, 2236	0.10	0.095	95
1888	0.10	0.089	89
2104	0.10	0.089	89

UCL = upper control limit, UWL = upper warning limit, LWL = lower warning limit, LCL = lower control limit.

Table 5. Continuing quality control data for the Winter 1992-93 San Joaquin River study.

Screen: Carbamate | UCL = 113 | Sample Type: Surface Water
Analyte: Carbofuran | UWL = 108 | Lab: CDFA
MDL: 0.05 ppb | LWL = 89 | Chemist: S. Richman
LCL = 84

Sample Analyzed with Each Extraction Set (Sample Number)	Spike Level (ppb)	Results (ppb)	Recovery (%)
2140	0.10	0.093	93
1924	0.10	0.084	84
1918, 2116	0.10	0.079	79*
2308, 2310	0.10	0.090	90
2128	0.10	0.094	94
1930	0.10	0.080	80*
2020, 2110, 1978, 2056, 2182, 1534, 2032, 1996, 2074	0.10	0.085	85
2068, 2062, 2188, 2122, 1522, 2038, 1912, 1894	0.10	0.095	95
2026, 2044, 2170, 2176	0.10	0.085	85
1972, 1990, 2050	0.10	0.096	96
1884	0.10	0.100	100
2254	0.10	0.093	93
2230	0.10	0.092	92
1906	0.10	0.085	85
1876, 1900, 1942, 2008, 2086, 2194, 2218, 2266, 2272, 2284	0.10	0.092	92
1936, 1948, 2092, 2098, 2146, 2207, 2212, 2260, 2278, 2290, 2296	0.10	0.084	84
2134, 2158, 2164, 2224, 2236	0.10	0.090	90
2248	0.10	0.087	87
1888	0.10	0.089	89
2104	0.10	0.086	86
2197	0.10	0.095	95

UCL = upper control limit, UWL = upper warning limit, LWL = lower warning limit, LCL = lower control limit.
* Matrix spike recoveries fell below the lower control limit.

Table 6. Continuing quality control data for the Winter 1992-93 San Joaquin River study.

Screen: Carbamate | UCL = 126 | Sample Type: Surface Water
Analyte: 3- Hydroxy carbofuran | UWL = 117 | Lab: CDFA
MDL: 0.05 ppb | LWL = 82 | Chemist: S. Richman
LCL = 73

Sample Analyzed with Each Extraction Set (Sample Number)	Spike Level (ppb)	Results (ppb)	Recovery (%)
2140	0.10	0.101	101
1924	0.10	0.078	78
1918, 2116	0.10	0.090	90
2308, 2310	0.10	0.095	95
2128	0.10	0.090	90
1930	0.10	0.082	82
2020, 2110, 1978, 2056, 2182, 1534, 2032, 1996, 2074	0.10	0.083	83
2068, 2062, 2188, 2122, 1522, 2038, 1912, 1894	0.10	0.096	96
2026, 2044, 2170, 2176	0.10	0.089	89
1972, 1990, 2050	0.10	0.096	96
1884	0.10	0.095	95
2254	0.10	0.085	85
2230	0.10	0.093	93
1906	0.10	0.100	100
1876, 1900, 1942, 2008, 2086, 2194, 2218, 2266, 2272, 2284	0.10	0.096	96
1936, 1948, 2092, 2098, 2146, 2207, 2212, 2260, 2278, 2290, 2296	0.10	0.086	86
2134, 2158, 2164, 2224, 2236	0.10	0.088	88
2248	0.10	0.082	82
1888	0.10	0.088	88
2104	0.10	0.083	83
2197	0.10	0.088	88

UCL = upper control limit, UWL = upper warning limit, LWL = lower warning limit, LCL = lower control limit.

Table 7. Continuing quality control data for the Winter 1992-93 San Joaquin River study.

Screen: Carbamate
Analyte: Methiocarb
MDL: 0.05 ppb

UCL = 120
UWL = 113
LWL = 84
LCL = 76

Sample Type: Surface Water
Lab: CDFA
Chemist: S. Richman

Sample Analyzed with Each Extraction Set (Sample Number)	Spike Level (ppb)	Results (ppb)	Recovery (%)
2140	0.10	0.098	98
1924	0.10	0.082	82
1918, 2116	0.10	0.084	84
2308, 2310	0.10	0.086	86
2128	0.10	0.088	88
1930	0.10	0.083	83
2020, 2110, 1978, 2056, 2182, 1534, 2032, 1996, 2074	0.10	0.078	78
2068, 2062, 2188, 2122, 1522, 2038, 1912, 1894	0.10	0.096	96
2026, 2044, 2170, 2176	0.10	0.089	89
1972, 1990, 2050	0.10	0.095	95
1884	0.10	0.096	96
2254	0.10	0.088	88
2230	0.10	0.095	95
1906	0.10	0.087	87
1876, 1900, 1942, 2008, 2086, 2194, 2218, 2266, 2272, 2284	0.10	0.093	93
1936, 1948, 2092, 2098, 2146, 2207, 2212, 2260, 2278, 2290, 2296	0.10	0.086	86
2134, 2158, 2164, 2224, 2236	0.10	0.086	86
2248	0.10	0.071	71*
1888	0.10	0.088	88
2104	0.10	0.080	80
2197	0.10	0.089	89

UCL = upper control limit, UWL = upper warning limit, LWL = lower warning limit, LCL = lower control limit.
* Matrix spike recovery fell below the lower control limit.

Table 8. Continuing quality control data for the Winter 1992-93 San Joaquin River study.

Screen: Carbamate
Analyte: Methomyl
MDL: 0.05 ppb

UCL = 123
UWL = 114
LWL = 79
LCL = 70

Sample Type: Surface Water
Lab: CDFA
Chemist: S. Richman

Sample Analyzed with Each Extraction Set (Sample Number)	Spike Level (ppb)	Results (ppb)	Recovery (%)
2140	0.10	0.098	98
1924	0.10	0.080	80
1918, 2116	0.10	0.088	88
2308, 2310	0.10	0.092	92
2128	0.10	0.094	94
1930	0.10	0.109	109
2020, 2110, 1978, 2056, 2182, 1534, 2032, 1996, 2074	0.10	0.078	78
2068, 2062, 2188, 2122, 1522, 2038, 1912, 1894	0.10	0.092	92
2026, 2044, 2170, 2176	0.10	0.080	80
1972, 1990, 2050	0.10	0.097	97
1884	0.10	0.098	98
2230	0.10	0.093	93
1906	0.10	0.086	86
1876, 1900, 1942, 2008, 2086, 2194, 2218, 2266, 2272, 2284	0.10	0.094	94
1936, 1948, 2092, 2098, 2146, 2207, 2212, 2260, 2278, 2290, 2296	0.10	0.088	88
2134, 2158, 2164, 2224, 2236	0.10	0.086	86
2248	0.10	0.079	79
1888	0.10	0.089	89
2104	0.10	0.080	80
2197	0.10	0.079	79

UCL = upper control limit, UWL = upper warning limit, LWL = lower warning limit, LCL = lower control limit.

Appendix III. Continuing QC. Carbamate Screen - Winter 1992-93

Table 9. Continuing quality control data for the Winter 1992-93 San Joaquin River study.

Screen: Carbamate	UCL = 130	Sample Type: Surface Water
Analyte: Oxamyl	UWL = 119	Lab: CDFA
MDL: 0.05 ppb	LWL = 77	Chemist: S. Richman
	LCL = 66	

Sample Analyzed with Each Extraction Set (Sample Number)	Spike Level (ppb)	Results (ppb)	Recovery (%)
2140	0.10	0.096	96
1918, 2116	0.10	0.098	98
2308, 2310	0.10	0.088	88
1930	0.10	0.106	106
2020, 2110, 1978, 2056, 2182, 1534, 2032, 1996, 2074	0.10	0.085	85
2068, 2062, 2188, 2122, 1522, 2038, 1912, 1894	0.10	0.092	92
1972, 1990, 2050	0.10	0.096	96
1884	0.10	0.110	110
2254	0.10	0.097	97
2014, 2200	0.10	0.104	104
2230	0.10	0.096	96
1906	0.10	0.086	86
1936, 1948, 2092, 2098, 2146, 2207, 2212, 2260, 2278, 2290, 2296	0.10	0.100	100
2134, 2158, 2164, 2224, 2236	0.10	0.098	98
1888	0.10	0.097	97
2104	0.10	0.093	93

UCL = upper control limit, UWL = upper warning limit, LWL = lower warning limit, LCL = lower control limit.

Appendix III. Continuing QC. Endosulfan Screen - Winter 1991-92

Table 1. Continuing quality control data for the Winter 1991-92 San Joaquin River study.

Screen: Endosulfan	UCL = 109	Sample Type: Surface Water
Analyte: Diazinon	UWL = 104	Lab: CDFA
MDL: 0.05 ppb	LWL = 86	Chemist: K. Hefner
	LCL = 81	

Sample Analyzed with Each Extraction Set (Sample Number)	Spike Level (ppb)	Results (ppb)	Recovery (%)
754, 850	0.20	0.20	100
760, 898, 928	0.10	0.11	110**
904	0.10	0.10	100
595, 826	0.10	0.12	120**
778, 814	0.12	0.13	108
796	0.12	0.12	100
886	0.12	0.13	108
955, 962, 1045, 1083, 1101, 1113, 1367, 1373	0.12	0.13	108
973, 1053, 1059, 1077, 1089, 1125, 1137, 1143, 1271, 1277	0.12	0.11	92
1071	0.12	0.11	92
1307	0.12	0.11	92
1349	0.12	0.11	92
868	0.12	0.12	100
1015, 1095, 1003, 1009, 1000, 590, 948, 979, 1039, 941	0.10	0.11	110**
874, 890, 967, 985, 991, 1021, 1027, 1033, 1149, 1155, 1313	0.10	0.09	90
1107	0.10	0.11	110**
1337	0.10	0.11	110**

UCL = upper control limit, UWL = upper warning limit, LWL = lower warning limit, LCL = lower control limit.
** Matrix spike recoveries fell above the upper control limit.

Table 2. Continuing quality control data for the Winter 1991-92 San Joaquin River study.

Screen: Endosulfan	UCL = 120	Sample Type: Surface Water
Analyte: Diazinon OA	UWL = 115	Lab: CDFA
MDL: 0.05 ppb	LWL = 93	Chemist: K. Hefner
	LCL = 88	

Sample Analyzed with Each Extraction Set (Sample Number)	Spike Level (ppb)	Results (ppb)	Recovery (%)
754, 850	0.20	0.21	105
760, 898, 928	0.10	0.11	110
904	0.10	0.10	100
595, 826	0.10	0.13	130**
778, 814	0.12	0.14	117
796	0.12	0.13	108
886	0.12	0.13	108
955, 962, 1045, 1083, 1101, 1113, 1367, 1373	0.12	0.13	108
973, 1053, 1059, 1077, 1089, 1125, 1137, 1143, 1271, 1277	0.12	0.11	92
1071	0.12	0.11	92
1307	0.12	0.12	100
1349	0.12	0.11	92
868	0.12	0.12	100
1015, 1095, 1003, 1009, 1000, 590, 948, 979, 1039, 941	0.10	0.10	100
874, 890, 967, 985, 991, 1021, 1027, 1033, 1149, 1155, 1313	0.10	0.11	110
1107	0.10	0.09	90
1337	0.10	0.11	110

UCL = upper control limit, UWL = upper warning limit, LWL = lower warning limit, LCL = lower control limit.
** Matrix spike recoveries fell above the upper control limit.

Appendix III. Continuing QC. Endosulfan Screen - Winter 1991-92

Table 3. Continuing quality control data for the Winter 1991-92 San Joaquin River study.

Screen: Endosulfan
Analyte: Endosulfan I
MDL: 0.005 ppb

UCL = 113
UWL = 106
LWL = 76
LCL = 69

Sample Type: Surface Water
Lab: CDFA
Chemist: K. Hefner

Sample Analyzed with Each Extraction Set (Sample Number)	Spike Level (ppb)	Results (ppb)	Recovery (%)
754, 850	0.20	0.16	80
760, 898, 928	0.10	0.08	80
904	0.10	0.09	90
595, 826	0.10	0.11	110
778, 814	0.10	0.09	90
796	0.10	0.12	120**
886	0.10	0.08	80
955, 962, 1045, 1083, 1101, 1113, 1367, 1373	0.10	0.10	100
973, 1053, 1059, 1077, 1089, 1125, 1137, 1143, 1271, 1277	0.10	0.08	80
1071	0.10	0.08	80
1307	0.10	0.11	110
1349	0.10	0.08	80
868	0.10	0.10	100
1015, 1095, 1003, 1009, 1000, 590, 948, 979, 1039, 941	0.10	0.08	80
874, 890, 967, 985, 991, 1021, 1027, 1033, 1149, 1155, 1313	0.10	0.10	100
1107	0.10	0.12	120**
1337	0.10	0.10	100

UCL = upper control limit, UWL = upper warning limit, LWL = lower warning limit, LCL = lower control limit.
** Matrix spike recoveries fell above the upper control limit.

Table 4. Continuing quality control data for the Winter 1991-92 San Joaquin River study.

Screen: Endosulfan
Analyte: Endosulfan II
MDL: 0.005 ppb

UCL = 145
UWL = 131
LWL = 75
LCL = 60

Sample Type: Surface Water
Lab: CDFA
Chemist: K. Hefner

Sample Analyzed with Each Extraction Set (Sample Number)	Spike Level (ppb)	Results (ppb)	Recovery (%)
754, 850	0.20	0.21	105
760, 898, 928	0.10	0.12	120
904	0.10	0.09	90
595, 826	0.10	0.11	110
778, 814	0.10	0.09	90
796	0.10	0.10	100
886	0.10	0.09	90
955, 962, 1045, 1083, 1101, 1113, 1367, 1373	0.10	0.10	100
973, 1053, 1059, 1077, 1089, 1125, 1137, 1143, 1271, 1277	0.10	0.08	80
1071	0.10	0.08	80
1307	0.10	0.12	120
1349	0.10	0.08	80
868	0.10	0.10	100
1015, 1095, 1003, 1009, 1000, 590, 948, 979, 1039, 941	0.10	0.09	90
874, 890, 967, 985, 991, 1021, 1027, 1033, 1149, 1155, 1313	0.10	0.12	120
1107	0.10	0.10	100
1337	0.10	0.10	100

UCL = upper control limit, UWL = upper warning limit, LWL = lower warning limit, LCL = lower control limit.

Appendix III. Continuing QC. Endosulfan Screen - Winter 1991-92

Table 5. Continuing quality control data for the Winter 1991-92 San Joaquin River study.

Screen: Endosulfan	UCL = 147	Sample Type: Surface Water
Analyte: Endosulfan Sulfate	UWL = 131	Lab: CDFA
MDL: 0.01 ppb	LWL = 68	Chemist: K. Hefner
	LCL = 52	

Sample Analyzed with Each Extraction Set (Sample Number)	Spike Level (ppb)	Results (ppb)	Recovery (%)
754, 850	0.20	0.20	100
760, 898, 928	0.10	0.10	100
904	0.10	0.13	130
595, 826	0.10	0.13	130
778, 814	0.10	0.11	110
796	0.10	0.08	80
886	0.10	0.13	130
955, 962, 1045, 1083, 1101, 1113, 1367, 1373	0.10	0.14	140
973, 1053, 1059, 1077, 1089, 1125, 1137, 1143, 1271, 1277	0.10	0.11	110
1071	0.10	0.10	100
1307	0.10	0.12	120
1349	0.10	0.08	80
868	0.10	0.12	120
1015, 1095, 1003, 1009, 1000, 590, 948, 979, 1039, 941	0.10	0.12	120
874, 890, 967, 985, 991, 1021, 1027, 1033, 1149, 1155, 1313	0.10	0.11	110
1107	0.10	0.10	100
1337	0.10	0.08	80

UCL = upper control limit, UWL = upper warning limit, LWL = lower warning limit, LCL = lower control limit.

Appendix III. Continuing QC. Endosulfan Screen - Winter 1992-93

Table 1. Continuing quality control data for the Winter 1992-93 San Joaquin River study.

Screen: Endosulfan	UCL = 109	Sample Type: Surface Water
Analyte: Diazinon	UWL = 104	Lab: CDFA
MDL: 0.05 ppb	LWL = 86	Chemist: K. Hefner
	LCL = 81	

Sample Analyzed with Each Extraction Set (Sample Number)	Spike Level (ppb)	Results (ppb)	Recovery (%)
2141	0.50	0.45	90
1925	0.50	0.46	92
1919, 2117, 2303, 2311	0.50	0.50	100
2129, 2306	0.50	0.47	94
1523, 1991, 2021, 2033, 2045, 2057, 2123, 2171, 2183	0.50	0.48	96
1973, 1979, 1997, 2027, 2039, 2111, 2189	0.50	0.48	96
1535, 1895, 1913, 2063, 2075, 2177	0.50	0.48	96
1885, 2255, 2397, 2403	0.05	0.05	100
2078, 2401	0.05	0.05	100
2015, 2204	0.50	0.46	92
1907, 2335	0.05	0.05	100
1937, 1943, 2285, 2147	0.05	0.05	100
1877, 1901, 1949, 2093, 2195, 2208, 2213, 2219, 2273, 2279, 2291	0.50	0.49	98
2099, 2135, 2159, 2165, 2225, 2237, 2249, 2261, 2297	0.50	0.47	94
1889, 2324	0.50	0.43	86
2105	0.50	0.49	98

UCL = upper control limit, UWL = upper warning limit, LWL = lower warning limit, LCL = lower control limit.

Table 2. Continuing quality control data for the Winter 1992-93 San Joaquin River study.

Screen: Endosulfan	UCL = 120	Sample Type: Surface Water
Analyte: Diazinon OA	UWL = 115	Lab: CDFA
MDL: 0.05 ppb	LWL = 93	Chemist: K. Hefner
	LCL = 88	

Sample Analyzed with Each Extraction Set (Sample Number)	Spike Level (ppb)	Results (ppb)	Recovery (%)
2141	0.50	0.50	100
1925	0.50	0.52	104
1919, 2117, 2303, 2311	0.50	0.53	106
2129, 2306	0.50	0.51	102
1523, 1991, 2021, 2033, 2045, 2057, 2123, 2171, 2183	0.50	0.52	104
1973, 1979, 1997, 2027, 2039, 2111, 2189	0.50	0.45	90
1535, 1895, 1913, 2063, 2075, 2177	0.50	0.45	90
1885, 2255, 2397, 2403	0.05	0.05	100
2078, 2401	0.05	0.06	120
2015, 2204	0.50	0.48	96
1907, 2335	0.05	0.05	100
1937, 1943, 2285, 2147	0.05	0.05	100
1877, 1901, 1949, 2093, 2195, 2208, 2213, 2219, 2273, 2279, 2291	0.50	0.48	96
2099, 2135, 2159, 2165, 2225, 2237, 2249, 2261, 2297	0.50	0.48	96
1889, 2324	0.50	0.44	88
2105	0.50	0.50	100

UCL = upper control limit, UWL = upper warning limit, LWL = lower warning limit, LCL = lower control limit.

Table 3. Continuing quality control data for the Winter 1992-93 San Joaquin River study.

Screen: Endosulfan | UCL = 113 | Sample Type: Surface Water
Analyte: Endosulfan I | UWL = 106 | Lab: CDFA
MDL: 0.005 ppb | LWL = 76 | Chemist: K. Hefner
LCL = 69

Sample Analyzed with Each Extraction Set (Sample Number)	Spike Level (ppb)	Results (ppb)	Recovery (%)
2141	0.50	0.42	84
1925	0.50	0.53	106
1919, 2117, 2303, 2311	0.50	0.48	96
2129, 2306	0.50	0.45	90
1523, 1991, 2021, 2033, 2045, 2057, 2123, 2171, 2183	0.50	0.45	90
1973, 1979, 1997, 2027, 2039, 2111, 2189	0.50	0.54	108
1535, 1895, 1913, 2063, 2075, 2177	0.10	0.10	100
1885, 2255, 2397, 2403	0.02	0.02	100
2078, 2401	0.02	0.02	100
2015, 2204	0.50	0.44	88
1907, 2335	0.02	0.02	100
1937, 1943, 2285, 2147	0.02	0.02	100
1877, 1901, 1949, 2093, 2195, 2208, 2213, 2219, 2273, 2279, 2291	0.50	0.50	100
2099, 2135, 2159, 2165, 2225, 2237, 2249, 2261, 2297	0.50	0.46	92
1889, 2324	0.50	0.39	78
2105	0.50	0.47	94

UCL = upper control limit, UWL = upper warning limit, LWL = lower warning limit, LCL = lower control limit.

Table 4. Continuing quality control data for the Winter 1992-93 San Joaquin River study.

Screen: Endosulfan | UCL = 145 | Sample Type: Surface Water
Analyte: Endosulfan II | UWL = 131 | Lab: CDFA
MDL: 0.005 ppb | LWL = 75 | Chemist: K. Hefner
LCL = 60

Sample Analyzed with Each Extraction Set (Sample Number)	Spike Level (ppb)	Results (ppb)	Recovery (%)
2141	0.50	0.39	78
1925	0.50	0.53	106
1919, 2117, 2303, 2311	0.50	0.48	96
2129, 2306	0.50	0.45	90
1523, 1991, 2021, 2033, 2045, 2057, 2123, 2171, 2183	0.50	0.49	98
1973, 1979, 1997, 2027, 2039, 2111, 2189	0.50	0.60	120
1535, 1895, 1913, 2063, 2075, 2177	0.10	0.11	110
1885, 2255, 2397, 2403	0.02	0.02	100
2078, 2401	0.02	0.02	100
2015, 2204	0.50	0.37	74
1907, 2335	0.02	0.02	100
1937, 1943, 2285, 2147	0.02	0.02	100
1877, 1901, 1949, 2093, 2195, 2208, 2213, 2219, 2273, 2279, 2291	0.50	0.47	94
2099, 2135, 2159, 2165, 2225, 2237, 2249, 2261, 2297	0.50	0.40	80
1889, 2324	0.50	0.62	124
2105	0.50	0.47	94

UCL = upper control limit, UWL = upper warning limit, LWL = lower warning limit, LCL = lower control limit.

Appendix III. Continuing QC. Endosulfan Screen - Winter 1992-93

Table 5. Continuing quality control data for the Winter 1992-93 San Joaquin River study.

Screen: Endosulfan	UCL = 147	Sample Type: Surface Water
Analyte: Endosulfan Sulfate	UWL = 131	Lab: CDFA
MDL: 0.01 ppb	LWL = 68	Chemist: K. Hefner
	LCL = 52	

Sample Analyzed with Each Extraction Set (Sample Number)	Spike Level (ppb)	Results (ppb)	Recovery (%)
2141	0.50	0.40	80
1925	0.50	0.47	94
1919, 2117, 2303, 2311	0.50	0.62	124
2129, 2306	0.50	0.50	100
1523, 1991, 2021, 2033, 2045, 2057, 2123, 2171, 2183	0.50	0.52	104
1973, 1979, 1997, 2027, 2039, 2111, 2189	0.50	0.51	102
1535, 1895, 1913, 2063, 2075, 2177	0.10	0.12	120
1885, 2255, 2397, 2403	0.02	0.02	100
2078, 2401	0.02	0.02	100
2015, 2204	0.50	0.60	120
1907, 2335	0.02	0.02	100
1937, 1943, 2285, 2147	0.02	0.02	100
1877, 1901, 1949, 2093, 2195, 2208, 2213, 2219, 2273, 2279, 2291	0.50	0.52	104
2099, 2135, 2159, 2165, 2225, 2237, 2249, 2261, 2297	0.50	0.42	84
1889, 2324	0.50	0.62	124
2105	0.50	0.44	88

UCL = upper control limit, UWL = upper warning limit, LWL = lower warning limit, LCL = lower control limit.

APPENDIX IV. BLIND SPIKE RESULTS

Appendix IV. Blind Spike Results

Table 1. Blind Spike Data for the Winter (1991-92 and 1992-93) San Joaquin River Study.

Analyte	Spike Level (ppb)	Results (ppb)	Recovery (%)	Date Analyzed
Organophosphate Screen				
Chlorpyrifos	0.05	0.058	116	12/30/91
	0.05	0.058	116	12/31/91
	0.10	0.093	93	1/14/92
	0.05	0.052	104	1/24/92
	0.05	0.050	100	2/28/92
	0.05	0.054	108	1/8/93
	0.05	0.050	100	1/21/93
Diazinon	0.05	0.053	106	1/24/92
	0.05	0.060	120	2/28/92
	0.07	0.080	114	1/29/93
Ethyl Parathion	0.05	0.050	100	12/30/91
	0.05	0.050	100	12/31/91
	0.10	0.105	105	1/14/92
	0.05	0.054	108	1/24/92
	0.05	0.060	120**	2/28/92
Methidathion	0.05	0.052	104	12/31/91
	0.05	0.054	108	1/24/92
	0.05	0.050	100	2/28/92
	0.10	0.097	97	1/8/93
	0.10	0.110	110	1/11/93
Phosmet	0.10	0.097	97	1/14/92
Carbamate Screen				
Aldicarb	0.05	0.060	120**	1/3/91
	0.05	0.050	100	1/3/91
Carbaryl	0.07	0.070	100	1/8/93
	0.07	0.067	96	1/14/93
Carbofuran	0.05	0.050	100	1/3/91
	0.05	0.050	100	1/3/91
	0.15	0.120	80*	1/16/92
Endosulfan Screen				
Diazinon	0.15	0.16	107	1/8/92
	0.15	0.13	87	1/15/92
	0.15	0.13	87	2/21/92
	0.05	0.05	100	1/8/93
	0.07	0.08	114**	1/29/93
Diazinon OA	0.07	0.05	70*	2/11/93
Endosulfan I	0.15	0.16	107	1/8/92
	0.15	0.14	93	1/15/92
Endosulfan sulfate	0.08	0.08	105	2/29/93

* Matrix spike recovery fell below the lower control limit.

** Matrix spike recovery fell above the upper control limit.

APPENDIX V. FIELD RINSE SAMPLE RESULTS

Appendix V. Field-rinse sample results from the 1991-92 and 1992-93 winter seasons..

Date	Site[a]	OP[b]	CB[c]	EN[d]	TSS[e]	TOC[f]
1/2/92	12	ND[g]	ND	ND	ND	ND
1/16/92	12	ND	ND	ND	ND	ND
1/28/92	5	ND	ND	ND	ND	ND
1/30/92	12	ND	ND	ND	ND	ND
1/31/92	17	ND	ND	ND	ND	ND
2/18/92	8	ND	ND	ND	ND	ND
2/19/92	12	ND	ND	ND	ND	ND
1/7/93	12	ND[h]	ND[i]	ND	ND	ND
1/16/93	8	ND	ND[j]	ND	ND	ND
1/17/93	15	ND	ND	ND	ND	ND
2/1/93	12	ND	ND	ND	ND	ND
2/9/93	7	ND	ND	ND	ND	ND
2/10/93	17	ND	ND	ND	ND	ND

a. Site numbers and corresponding names are listed in Table 1.
b. Organophosphates (see Table 2 for list of insecticides and method detection limits).
c. Carbamates (see Table 2 for list of insecticides and method detection limits).
d. Endosulfans (see Table 2 for list of insecticides and method detection limits).
e. Total suspended sediment. Method detection limit is 3.0 mg/L.
f. Total organic carbon. Method detection limit is 4.0 mg/L.
g. None detected.
h. Companion quality control spike was low for azinphos-methyl OA (see Appendix III).
i. Companion quality control spike was low for carbofuran.
j. Companion quality control spike was low for aldicarb sulfone.

APPENDIX VI. TEMPORAL VARIATION IN WATER QUALITY PARAMETERS

Appendix VI. Temporal variation in water quality and discharge measurements made in the San Joaquin River at Laird Park (site 12) during the 1991-92 and 1992-93 dormant spray seasons.

Date	Water Temp. (C°)	pH	DO[a] (mg/L)	EC[b] (µS/cm)	Total Ammonia (mg/L)	Discharge (ft^3/s)	TSS[c] (mg/L)	TOC[d] mg/L
12-23-91	8.7	7.7	11	1400	0.8	434	22	13
12-26-91	9.3	7.1	8.6	1390	0.6	458	29	4.2
12-30-91	11	7.1	8.9	1350	0.5	449	58	6.1
1-02-92	9.2	7.1	9.8	1380	0.2	456	26	4.5
1-06-92	10	7.1	8.2	1360	1	521	74	18
1-13-92	8.3	7.3	NA[e]	1390	0.9	510	32	7.0
1-16-92	8.3	7.2	10	1480	0.8	520	40	7.6
1-20-92	8.4	7.3	8.8	1560	2	500	44	9.3
1-23-92	7.5	7.7	9.6	1510	1	500	27	5.3
1-30-92[f]	10	6.9	8.8	1550	2	509	54	5.5
2-03-92	11	7.3	9.6	1610	0.8	485	52	6.9
2-06-92	11	7.7	8.6	1590	0.9	500	52	5.8
2-10-92	13	7.4	8.7	1550	0.8	532	73	8.9
2-13-92	13	7.4	6.9	1150	1	900	310	17
2-19-92[f]	12	7.1	7.2	501	2	2455	250	19
2-24-92	14	7.2	7.0	1190	0.8	1220	140	14
2-27-92	16	7.3	7.2	1460	0.7	934	110	13

Appendix VI. Temporal variation in water quality and discharge measurements made in the San Joaquin River at Laird Park (site 12) during the 1991-92 and 1992-93 dormant spray seasons.

Date	Water Temp. (C°)	pH	DO[a] (mg/L)	EC[b] (µS/cm)	Total Ammonia (mg/L)	Discharge (ft^3/s)	TSS[c] (mg/L)	TOC[d] mg/L
12-29-92	8.6	7.2	9.0	1540	1	416	39	<4.0
1-04-93	7.5	NA	10	1630	0.6	569	32	4.8
1-07-93	7.5	6.8	9.8	980	0.8	686	190	12
1-11-93	9.5	6.1	8.1	270	0.8	2150	250	14
1-14-93	10	6.8	9.6	407	0.6	4100	1100	24
1-17-93[f]	10	7.2	7.5	333	0.9	4140	180	11
1-21-93	12	6.7	7.8	758	0.8	4950	110	10
1-25-93	10	6.9	8.0	656	0.8	3740	84	9.4
1-28-93	9.0	6.9	8.9	926	0.8	2354	73	7.8
2-01-93	9.5	7.3	8.3	1310	0.8	1460	49	6.3
2-04-93	11	7.4	9.0	1520	0.6	1140	47	5.6
2-10-93[f]	11	7.0	8.4	1230	3	1950	188	14
2-11-93	13	6.9	7.7	797	1	2400	170	13
2-15-93	13	7.3	8.8	1220	0.8	1650	80	11
2-18-93	12	7.3	8.3	1550	0.9	1390	70	12
2-22-93	12	7.4	8.6	1030	0.6	2350	140	8.9
2-25-93	12	7.3	9.4	1020	0.6	2380	63	10

a. DO = dissolved oxygen.
b. EC = electrical conductivity, at 25°C, in microsiemens per centimeter (µS/cm).
c. TSS = total suspended sediment. Method detection limit = 0.3 mg/L.
d. TOC = total organic carbon. Method detection limit = 1.0 mg/L.
e. NA = not available.
f. Indicates Lagrangian sample.

APPENDIX VII. SPATIAL VARIATION IN WATER QUALITY PARAMETERS

Appendix VII. Water quality and discharge measurements made during the Lagrangian surveys conducted in the 1991-92 and 1992-93 dormant spray seasons.

Date	Site	Hour	Water Temp. (C°)	pH	DO[a] (mg/L)	EC[b] (µS/cm)	Total Ammonia (mg/L)	Discharge (ft^3/s)	TSS[c] (mg/L)	TOC[d] (mg/L)
1-27-92	1	1615	10	8.0	10	1320	0.6	3.0	16	6.5
1-27-92	2	1115	9.0	7.6	10	3580	0.7	84	52	7.4
1-28-92	18	0900	8.0	7.3	9.9	3370	0.4	97	53	5.3
1-27-92	3	1300	10	7.9	9.4	3430	0.6	7.9	36	14
1-27-92	4	1500	10	8.2	14	5690	0.4	<1.0	33	6.9
1-28-92	5	1130	8.0	7.3	7.3	1140	1	5.3	34	7.4
1-28-92	6	1550	9.0	7.2	11	85	0.2	219	16	<4.0
1-28-92	7	1600	10	7.8	9.6	1440	0.3	406	30	<4.0
1-29-92	8	0300	No water in Orestimba Creek at time of sampling.							
1-29-92	9	1330	15	7.6	2.3	2180	>10	17	310	210
1-29-92	10	1930	10	7.5	8.4	1560	3	418	55	13
1-30-92	11	0300	No water in Del Puerto Creek at time of sampling.							
1-30-92	12	1200	10	6.9	8.8	1550	2	509	54	5.5
1-30-92	13	0920	10	6.5	10	213	0.1	204	21	<4.0
1-30-92	14	1600	12	7.4	10	1670	2	3.9	88	<4.0
1-30-92	15	2245	10	7.5	8.4	1260	2	669	38	5.1
1-30-92	16	1700	10	6.9	10	140	<0.1	187	12	<4.0
1-31-92	17	0345	10	7.7	8.4	1050	1	947	46	4.9
2-17-92	1	0900	11	6.5	7.6	151	0.8	1510	380	25

Appendix VII. Water quality and discharge measurements made during the Lagrangian surveys conducted in the 1991-92 and 1992-93 dormant spray seasons.

Date	Site	Hour	Water Temp. (C°)	pH	DO[a] (mg/L)	EC[b] (µS/cm)	Total Ammonia (mg/L)	Discharge (ft^3/s)	TSS[c] (mg/L)	TOC[d] (mg/L)
2-17-92	2	0740	12	7.5	8.7	2440	0.9	191	130	14
2-17-92	18	2010	12	6.6	7.8	195	0.7	1700	190	18
2-17-92	3	1330	13	7.5	8.2	1800	0.8	180	60	17
2-17-92	4	1650	14	7.1	7.1	1320	0.9	153	40	21
2-17-92	5	2300	12	6.8	6.5	800	1	0[e]	180	21
2-18-92	6	0130	11	6.8	8.3	120	0.8	593	140	18
2-18-92	7	0300	12	6.8	6.6	395	0.5	2310	270	20
2-18-92	8	0900	11	7.1	8.8	333	0.1	40	100	9.6
2-18-92	9	1600	15	7.3	3.9	1340	>10	73	210	110
2-18-92	10	1930	12	6.9	6.9	423	2	2450	300	23
2-19-92	11	2400	13	8.1	10	870	0.5	14[f]	100	9.4
2-19-92	12	0530	12	7.1	7.2	501	2	2460	250	19
2-19-92	13	0240	12	6.7	8.5	179	0.8	761	64	13
2-19-92	14	0940	13	7.5	9.2	1440	1	12	200	12
2-19-92	15	1130	12	6.9	7.2	392	2	3180	260	20
2-19-92	16	0800	12	6.6	8.0	162	2	318	44	13
2-19-92	17	1500	13	6.9	7.2	352	2	3870	160	20
1-15-93	1	1200	11	7.0	8.1	133	0.7	3500	100	14
1-15-93	2	0920	11	7.6	8.5	3030	0.3	146	78	9.8
1-15-93	18	2000	11	6.8	8.2	176	0.5	3650[f]	110	11

Appendix VII. Water quality and discharge measurements made during the Lagrangian surveys conducted in the 1991-92 and 1992-93 dormant spray seasons.

Date	Site	Hour	Water Temp. (C°)	pH	DO[a] (mg/L)	EC[b] (µS/cm)	Total Ammonia (mg/L)	Discharge (ft^3/s)	TSS[c] (mg/L)	TOC[d] (mg/L)
1-15-93	3	1400	11	8.4	8.8	1390	0.8	305	100	6.2
1-15-93	4	1800	12	7.5	8.0	470	0.7	155	130	13
1-15-93	5	2300	11	6.5	4.8	414	1	0	440	13
1-14-93	20	1900	11	6.7	9.7	90	0.2	NA[g]	30	7.3
1-15-93	21	0645	10	7.0	9.0	119	0.1	NA	27	<4.0
1-16-93	6	0215	11	6.5	8.7	93	1	1000	190	20
1-16-93	7	0310	11	6.4	7.9	222	1	3850	150	20
1-16-93	8	1030	9.2	7.9	11	315	0.5	318	140	6.9
1-16-93	19	1315	9.7	6.9	11	761	0.1	3	1800	24
1-16-93	9	1600	13	7.5	4.1	1475	>10	35	80	21
1-16-93	10	2015	11	6.8	7.8	305	1	3970	170	13
1-16-93	11	2220	10	8.0	11	557	0.4	67	96	5.5
1-17-93	12	0430	10	7.2	7.5	333	0.9	4140	180	11
1-17-93	13	0030	10	7.0	8.2	144	0.5	910	38	7.1
1-17-93	14	0700	9.6	7.0	9.9	1390	0.3	16	130	7.3
1-17-93	15	1000	11	6.9	8.4	295	0.9	5190	190	15
1-17-93	16	0500	10	NA	9.5	121	0.6	258	26	6.5
1-17-93	17	1200	11	7.0	8.2	266	0.9	6130	200	11
2-08-93	1	1700	13	6.5	6.6	418	0.2	179	53	4.6
2-08-93	2	1150	14	7.4	8.2	3770	0.8	190	100	8.4
2-09-93	18	0200	13	7.4	7.9	2380	0.4	426	64	5.7
2-08-93	3	1810	14	7.5	9.8	2080	1	69	170	16
2-08-93	4	2000	13	7.2	5.7	1560	0.6	69	89	17

Appendix VII. Water quality and discharge measurements made during the Lagrangian surveys conducted in the 1991-92 and 1992-93 dormant spray seasons.

Date	Site	Hour	Water Temp. (C°)	pH	DO[a] (mg/L)	EC[b] (µS/cm)	Total Ammonia (mg/L)	Discharge (ft^3/s)	TSS[c] (mg/L)	TOC[d] (mg/L)
2-09-93	5	0730	11	6.3	7.5	280	1	38	510	19
2-07-93	20	2045	13	6.5	9.4	104	<0.1	206	11	<4.0
2-08-93	21	0930	14	7.8	9.4	284	0.2	NA	23	11
2-09-93	22	0340	12	7.1	8.3	636	0.2	NA	5.0	<4.0
2-08-93	23	1330	14	7.3	9.3	436	7	NA	120	18
2-09-93	6	0900	12	6.4	8.2	189	1	336	49	5.3
2-09-93	7	1020	13	7.4	7.0	1650	0.8	1040	89	8.8
2-09-93	8	1500	12	7.5	9.7	307	0.6	282	340	12
2-09-93	19	1650	14	7.2	9.3	2140	1	5	350	11
2-09-93	9	2130	15	7.2	3.8	923	>10	83	190	28
2-10-93	10	0100	12	7.1	7.8	1230	1	1730	160	12
2-10-93	11	0400	9.7	7.7	NA	651	0.4	65	130	5.2
2-10-93	12	0900	11	7.0	8.4	1230	3	1950	180	14
2-10-93	13	0500	12	6.4	NA	110	1	2460	200	17
2-10-93	14	1230	12	7.5	NA	1000	0.4	14	110	<4.0
2-10-93	15	1500	13	6.7	NA	619	0.8	3990	170	14
2-10-93	16	1000	12	NA	9.4	147	0.6	532	110	11
2-10-93	17	1715	12	6.7	NA	546	1	4730	190	14

a. DO = dissolved oxygen.
b. EC = electrical conductivity measured in microsiemens per centimeter at 25°C.
c. TSS = total suspended sediment.
d. TOC = total organic carbon.
e. No water movement detected at time of sampling.
f. Discharge estimated.
g. NA = not available.

APPENDIX VIII. SIMPLE STATISTICS AND CORRELATION ANALYSIS OF WATER QUALITY PARAMETERS MEASURED AT LAIRD PARK

Appendix VIII. Simple statistics and correlation analysis of water quality measurements made at Laird Park in the winters of 1991-92 and 1992-93.

Simple Statistics

1991-92	Water Temp (°C)	pH	DO[a] (mg/L)	EC[b] (uS/cm)	Ammonia (mg/L)	Discharge (cfs)	TSS[c] (mg/L)	TOC[d] (mg/L)
Mean	10.6	7.3	8.7	1378	1.0	699	82	9.7
Std Dev. (n)	2.3 (17)	0.2 (17)	1.2 (16)	260 (17)	0.5 (17)	502 (17)	81 (17)	4.9 (17)
1992-93								
Mean	10.4	7.0	8.7	1010	0.9	2225	169	10.2
Standard Deviation	1.7 (17)	0.3 (16)	0.7 (17)	434 (17)	0.6 (17)	1329 (17)	249 (17)	5.0 (17)

Correlation Matrix and Probabilities[e]

	Water Temp	pH	DO	EC	Ammonia	Discharge	TSS	TOC
Water Temp Probability	1.000							
pH Probability	0.088 0.624	1.000						
DO Probability	-.660 0.0001	0.209 0.252	1.000					
EC Probability	-.097 0.584	0.643 0.0001	0.371 0.034	1.000				
Ammonia Probability	-.007 0.970	-.074 0.682	-.230 0.198	0.007 0.969	1.000			
Discharge Probability	0.223 0.204	-.459 0.007	-.363 0.038	-.827 0.0001	0.002 0.992	1.000		
TSS Probability	0.106 0.552	-.352 0.044	-.087 0.630	-.575 0.0004	0.011 0.951	0.493 0.003	1.000	
TOC Probability	0.370 0.031	-.277 0.118	-.353 0.044	-.576 0.0004	0.215 0.222	0.428 0.012	0.714 0.0001	1.000

a. Dissolved oxygen
b. Electrical Conductivity
c. Total suspended sediment
d. Total organic carbon
e. Correlation analysis done using a Pearson correlation and data combined from both winter seasons.